



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**
Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

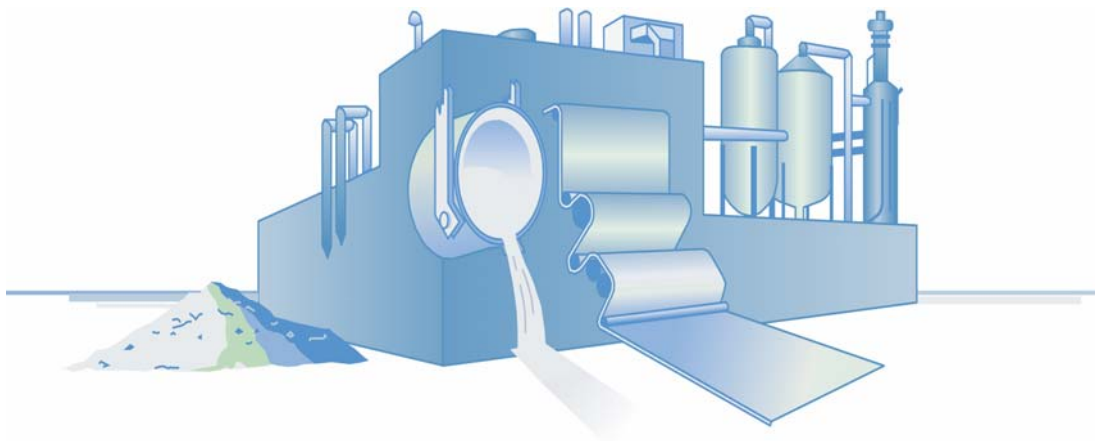


Industrial Technologies Program

Final Report

Forest Products Peer Review

April 5 - 7, 2006



July 2006

Table of Contents

INTRODUCTION.....	3
OVERVIEW OF THE FOREST PRODUCTS SUBPROGRAM.....	3
FOREST PRODUCTS PORTFOLIO STRATEGY.....	5
2006 FOREST PRODUCTS PEER REVIEW.....	8
PORTFOLIO CHARACTERIZATION	9
PORTFOLIO STRATEGY EVALUATION	11
PROJECT EVALUATION.....	13
PANEL 1 PROJECT EVALUATIONS	13
<i>Highly Efficient Directed-Green Liquor Utilization (D-GLU) Pulping.....</i>	13
<i>Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft cooks with Microwave Pretreatment.....</i>	14
<i>Hemicellulose Extraction and Its Integration.....</i>	14
<i>Improved Wood Properties Through Genetic Manipulation.....</i>	15
<i>Steam Cycle Washer for Unbleached Pulp.....</i>	15
<i>Laser Ultrasonics Web Stiffness Sensor.....</i>	16
<i>Development and Full-Scale Demonstration of Multiport Dryer Technology.....</i>	17
<i>Lateral Corrugator: An Improved Method of Manufacturing Corrugated Boxes.....</i>	17
<i>Improved Recovery Boiler Performance Through Control of Combustion, Sulfur, and Alkali Chemistry.....</i>	18
<i>Performance and Value of CAD-Deficient Pine.....</i>	19
<i>Development and Validation of Sterility Systems for Trees.....</i>	19
<i>On-Line Fluidics Controlled Headbox.....</i>	19
PANEL 2 PROJECT EVALUATIONS	20
<i>Development of Renewable Microbial Polyesters for Cost-Effective and Energy-Efficient Wood-Plastic Composites.....</i>	20
<i>Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives.....</i>	21
<i>HAPs Reduction from Drying and Pressing.....</i>	21
<i>Biological Air Emissions Control for an Energy Efficient Forest Products Industry of the Future.....</i>	22
<i>Fibrous Fillers to Manufacture Ultra-High Ash/Performance Paper.....</i>	23
<i>Development of Methane de-NO_x Reburning Process for Wastewood, Sludge, and Biomass Fired Stoker Boilers.....</i>	23
<i>Mechatronic Design and Control of a Waste Paper Sorting System for Efficient Recycling.....</i>	24
<i>VOC and HAP Recovery Using Ionic Liquids.....</i>	24
<i>Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites.....</i>	25
<i>An Innovative Titania-Activated Carbon System for Removal of VOCs and HAPs from Pulp, Paper, Paperboard Mills, and Wood Products Facilities with In-Situ Regeneration Capabilities</i>	25
<i>On-Line Oxidation of Volatile Compounds Generated by Sawmill Wood Kilns</i>	26
<i>Rapid, Low Temperature Electron, X-Ray, and Gamma-Beam Curable Resins.....</i>	26
REVIEWER RECOMMENDATIONS.....	28
PORTFOLIO RECOMMENDATIONS	28
PROJECT RECOMMENDATIONS	29
APPENDIX	32
APPENDIX A: STRATEGY QUESTIONS AND REVIEWER EVALUATIONS	32
APPENDIX B: PROJECT QUESTIONS AND REVIEWER EVALUATIONS	39

Introduction

Overview of the Forest Products Subprogram

The Industrial Technologies Program's (ITP) Forest Products subprogram has historically supported a diverse portfolio of cost-shared, pre-competitive research projects that aim to reduce the forest products industry's energy intensity. However, in response to reduced funding levels, the subprogram has had to narrow its focus by targeting only the largest energy savings opportunities.

The areas of greatest energy consumption are not necessarily the same as areas of greatest energy savings opportunities. For example, a 94% efficient condensing boiler can use a tremendous amount of energy, but there is little opportunity to save additional energy. In order to determine which energy savings opportunities to target, ITP has commissioned two recent studies. The first study, *The Energy and Environmental Profile of the Pulp and Paper Industry*, posted on the ITP website, profiles the pulp and papermaking processes and outlines the energy and environmental impacts of current unit processes. The second study is the Bandwidth Study, currently being written by Jacobs Engineering and Institute of Paper Science and Technology at Georgia Tech (IPST at GeorgiaTech) to determine what fraction of our existing energy consumption can actually be saved.

Figure 1 shows how ITP distinguishes between the energy savings which can be achieved from best practices and implementing current technologies, and the savings that can be achieved by developing new technologies. ITP addresses the first opportunity by disseminating information about commercialized ITP technologies and working with manufacturers to implement and disseminate best practices in energy management. The Technology Delivery subprogram coordinates ITP's best practices efforts. The second opportunity, developing new technologies, can only be addressed by new research and development (R&D).

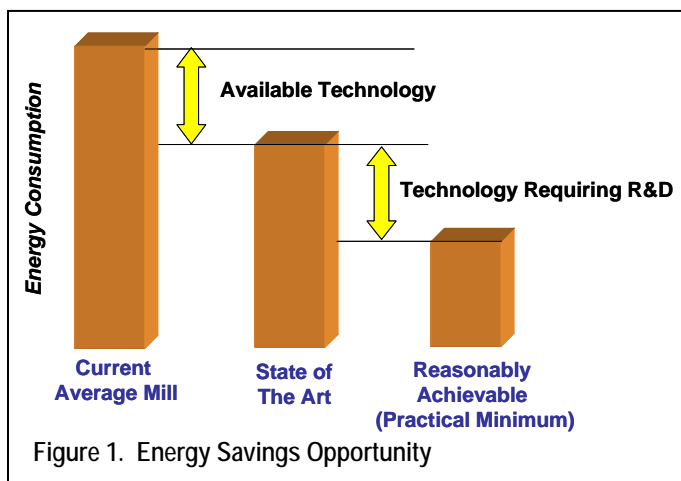


Figure 1. Energy Savings Opportunity

Working with Industry

Industry adoption is a crucial factor in the ultimate success of the Forest Products subprogram. Increasing the energy efficiency of the Forest Products sector requires the *development* and *deployment* of new technologies. ITP must understand industry's priorities and the reasons driving the marketplace adoption of each technology. In order to understand industry priorities, ITP maintains a strong partnership with American Forest & Paper Association (AF&PA) and seeks to only fund projects with significant public benefits (i.e. energy savings) and significant private benefits (e.g. lower costs, higher mill throughput, regulatory compliance). ITP determines the energy savings opportunities by conducting analytical studies and draws upon Agenda 2020 roadmaps to determine industry priorities.

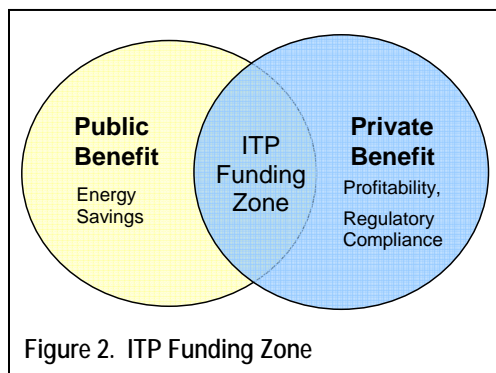
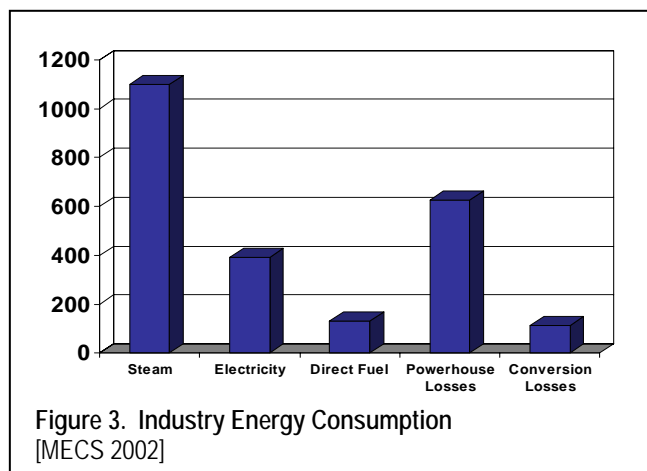


Figure 2. ITP Funding Zone

Figure 2 shows the energy consumption in the pulp and paper industry by trillions BTU (British Thermal Units) of steam, electricity, direct fuel, powerhouse losses and conversion losses. Other analyses conducted by ITP and identified in the updated industry roadmaps show the largest energy savings opportunities in the Forest Product Industry are:



- Reducing thermal drying in papermaking by increasing press solids to 70%
- Reducing evaporator load by cooking/washing with less water or devising alternative means of concentrating black liquor (e.g. membranes)
- Developing alternative pulping technologies
- Eliminating the lime kiln or firing it with alternative fuels
- Developing low-temperature curing resins that are compatible with high moisture content wood

Portfolio Goals

ITP's overall goal is to reduce the energy intensity of manufacturing. ITP is also targeting the reduction of natural gas usage because industry's reliance on this increasingly scarce and expensive fuel. In support of ITP's goals, the Forest Products subprogram focuses on developing technologies to reduce the steam demand of a state-of-the-art pulp and paper mill by 15% by 2015. In addition to saving energy, reducing the industry's steam demand will:

1. Reduce manufacturing costs
2. Make the biorefinery economically viable
3. Make gasification more attractive

In order for new technologies to be successfully commercialized, they must address industry's overall goal of increasing profits. Profits can be increased by reducing manufacturing costs or by expanding markets for existing and new products. The biorefinery concept and gasification technologies both target expanding the forest products industry's markets. Both of these technologies are currently being explored by EERE's Biomass Program. To avoid redundancies, ITP does not pursue direct R&D in these areas but does pursue R&D that could help enable the implementation of these technologies.

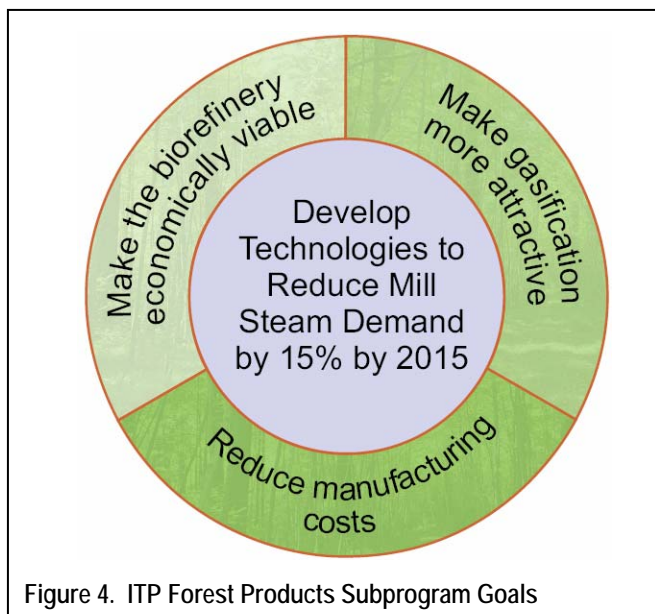


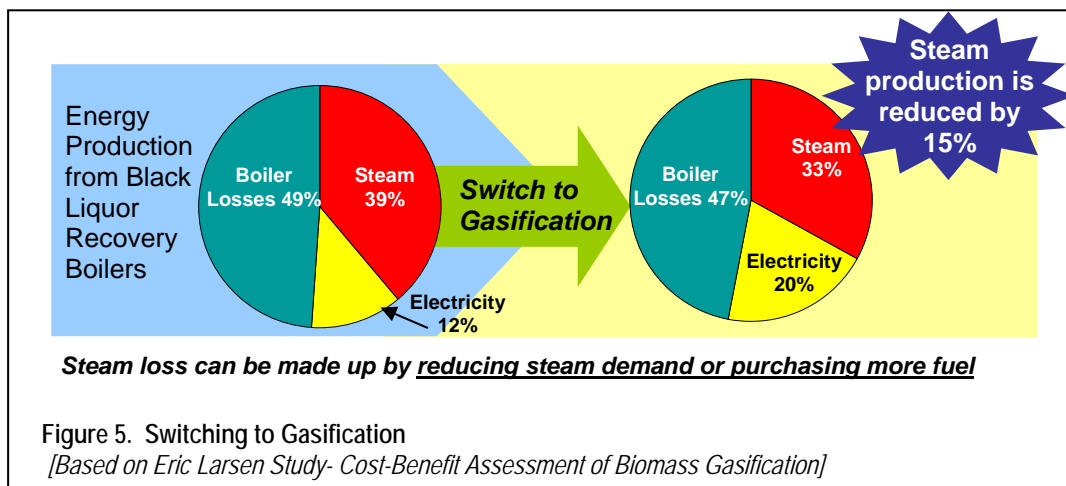
Figure 4. ITP Forest Products Subprogram Goals

Targeting Reductions in Steam Demand

By targeting the reduction of steam demand, the goals of the Forest Products subprogram and industry can be simultaneously met. The steam reduction goal will save natural gas in non-integrated mills and black liquor in integrated mills. Reducing a mill's dependence on natural gas helps meet ITP's goal of

lowering natural gas consumption and helps meet industry's goal of increasing profitability by reducing manufacturing costs.

Reducing the demand for black liquor in integrated mills enables black liquor gasification and the production of other products from black liquor. Black liquor gasification generates over 65% more electricity and produces roughly 15% less steam compared to conventional recovery boilers. To implement black liquor gasification, mills must reduce their steam demand by 15% or find a way to generate more steam. Reducing steam demand also enables black liquor to be used as chemical feedstock for the biorefinery at zero to near-zero incremental costs. Closing the "steam deficit" and allowing biochemicals to be produced at near zero incremental costs also helps industry achieve its overall goal of increasing profits by reducing manufacturing costs and expanding markets for new products.



Forest Products Portfolio Strategy

ITP's Forest Products Strategy is based on four elements:

1. Supporting ITP's mission of saving energy and industry's broader mission of developing gasification and the biorefinery
2. Using the barrier-pathway model to define and prioritize R&D focus areas
3. Issuing narrowly focused request for proposals (RFPs) to solicit projects which address specific technology barriers and pathways in the R&D focus areas
4. Funding projects by distinct stages of research

The Barrier-Pathway Model

The barrier-pathway model asks, "What are the technical barriers to more energy efficient processes, and what R&D pathways can be used to overcome these barriers?" ITP has applied this model to the energy savings opportunities in the Forest Products sector and has classified the resulting barriers and pathways under four focus areas:

1. Advanced Water Removal: aims to develop non-evaporative water removal technologies that will reduce the steam load for a pulp and paper mill.
2. High Efficiency Pulping: targets the development of technologies that will reduce the energy intensity of chemical pulping.

3. Innovative Wood Drying and Curing: seeks to develop drying, curing, and volatile organic compound (VOC) mitigation technologies that will reduce the energy intensity of the wood products sector.
4. Improved Fiber Recycling: targets the development of technologies that will increase the amount of fiber that can be recovered from waste paper.

The barriers and pathways for each of these focus areas are shown in Table 1. The Advanced Water Removal and High Efficiency Pulping focus areas are ITP's top priorities for future research and development. These priority focus areas target energy efficiency opportunities that reduce the industry's use of steam and natural gas.

Project Selection: Targeted RFPs and Merit Review

R&D projects for the Forest Products portfolio are selected through open, competitive solicitations. The selection process uses retired industry experts to evaluate proposals based on their energy savings potential, technical merit, commercialization potential, and the work plan and team capabilities.

ITP has recently changed the request for proposal (RFP) process. In the past, the Forest Products subprogram asked Principal Investigators to submit their best ideas under broad research topics. However, the Forest Products subprogram currently has a much smaller budget compared to previous years. This smaller budget has led the subprogram to solicit projects through focused RFPs that target the barriers and pathways identified by ITP analysis and industry roadmaps. For example, in the FY05 solicitation, the RFP targeted non-thermal technologies to increase press solids before the dryer section. In the future, we plan to issue RFPs that address the identified barriers and pathways, primarily in the Advanced Water Removal and High Efficiency Pulping focus areas.

Project Funding: Staged Funding

In the past, the Forest Products subprogram funded multistage projects that sought to develop a concept into a commercialized technology. These projects tended to stretch over many years, were relatively expensive, and often lacked go/no-go decision points or had poorly articulated go/no-go decision criteria. As a result, marginal projects continued to be funded even as portfolio priorities changed.

In order to address this problem, the Forest Products subprogram is implementing a system where only distinct phases of a project are funded. The four stages are:

- Stage 1** – Preliminary Investigation and Analysis: scoping studies to identify research topics; technical and market assessments; idea generation
- Stage 2** – Concept Definition: early stage research to explore and define technical concepts; laboratory scale research
- Stage 3** – Concept Development: development and testing of prototype technology or process; predictive modeling or simulation of performance; evaluation of scalability; demonstration of concept feasibility at the prototype or bench scale
- Stage 4** – Technology Development: pilot scale development and testing of technology or process; field testing and validation of technology

Projects will only be funded at higher stages when their merit is proven at lower stages. Higher stage projects will typically have higher funding levels and lower risk. Stage 1 and Stage 2 projects will typically be 1-2 year projects with a total funding of \$100,000, with Stage 1 projects emphasizing high level barriers and pathways and Stage 2 projects focusing on specific technical approaches to addressing these barriers and pathways. Stage 3 projects will typically be 2 year projects with total funding in the

Table 1. ITP's Forest Products Barriers and Pathways

Barriers	Pathways	Metrics
<i>Advanced Water Removal</i>		
<ul style="list-style-type: none"> Weak black liquor must be concentrated prior to chemical recovery Dewatering technologies are unable to dewater fibrous paper webs beyond 45-50% Press rewetting of the paper web prior to drying 	<ul style="list-style-type: none"> Develop non-evaporative technology to concentrate weak black liquor Develop a high consistency pulp washer for unbleached pulp to reduce the weak black liquor evaporation load Develop non-evaporative technology that reduces the paper drying load 	<ul style="list-style-type: none"> Demonstrate a 50% reduction in the weak black liquor evaporation load in a pulp mill field test Demonstrate a non-evaporative technology that dewateres the paper web to 70% dryness and reduces the evaporative drying energy requirement by 40% Technology transfer of R&D results to industry
<i>High Efficiency Pulping</i>		
<ul style="list-style-type: none"> Chemical pulping is energy and capital intensive with significant environmental impacts Chemical pulp yields are low due to cellulose and hemicellulose dissolution Lime kilns are energy intensive 	<ul style="list-style-type: none"> Develop a technology that will reduce the energy intensity of the current kraft pulping process Develop an alternative pulping process that will reduce the energy intensity of chemical pulping Develop autocausticization technologies in recovery boilers and gasifiers Develop a technology to fire a lime kiln with biomass syngas 	<ul style="list-style-type: none"> Demonstrate a 20% reduction in the energy intensity of chemical pulping at a mill Demonstrate kiln-free pulping technology Demonstrate a lime kiln fired by biomass syngas Technology transfer of R&D results to industry
<i>Improved Fiber Recycling</i>		
<ul style="list-style-type: none"> Contamination and mix of fiber types hinders fiber recycling PSAs and wax coatings are problem contaminants that can not be efficiently separated from the recycling stream Fiber strength is degraded during recycling 	<ul style="list-style-type: none"> Develop an automated, high-volume fiber characterization and sorting system for recovered paper Develop screenable water-based PSAs and wax coatings Develop a technology to improve the quality of recycled fibers 	<ul style="list-style-type: none"> Demonstrate a 10% increase in the economic recovery of recycled fiber at a recycled fiber mill Technology transfer of R&D results to industry
<i>Innovative Wood Drying and Curing</i>		
<ul style="list-style-type: none"> Current VOC and HAP emission control systems (i.e. RTOs) for forest product mills are energy intensive Current lumber drying and curing processes are energy intensive 	<ul style="list-style-type: none"> Develop an alternative, energy efficient technology to reduce VOC and HAP emissions Develop a technology to reduce the energy intensity of wood drying Develop a cold-setting laminated veneer lumber (LVL) adhesive that reduces the energy intensity of LVL curing 	<ul style="list-style-type: none"> Demonstrate a technology or strategy that reduces the energy intensity of emissions control by 20% Demonstrate a wood drying technology that reduces the energy intensity of wood drying by 20% Demonstrate a technology that reduces the energy intensity of LVL curing by 50%

range of \$150,000-\$400,000. Stage 4 projects will typically be 2-3 year projects with total funding in the \$1 million - \$2 million range. It will also be possible to award a Stage 2/Stage 3 project in one solicitation, but at the end of Stage 2, the project will need to go before a formal review process and objective go/no-go decision criteria will need to be fulfilled to move into the Stage 3 funding. Stage 4 projects can only be selected through the merit review process in response to a solicitation. Each year, the forest products portfolio will fund a mix of projects. For example, at current funding levels (\$3 million), the portfolio could fund one Stage 1 project, five to ten Stage 2 projects, two to four Stage 3 projects, and one to two Stage 4 projects.

2006 Forest Products Peer Review

The 2006 Forest Products Peer Review was held April 5-7, 2006 in Atlanta, Georgia. The purpose of the Peer Review was to review the goals, objectives, strategy, and projects of ITP's Forest Products subprogram. In addition to presenting the forest products strategy, in-depth presentations on technologies under development in ITP's forest products portfolio were given. Research from 24 projects was presented in two concurrent sessions on April 5 and 6 and in a poster session on April 5. Peer reviewers were retired industry experts selected from recommendations by the American Forest and Paper Association (AF&PA), the Technical Association of the Pulp and Paper Industry (TAPPI), and other industry representatives. The peer reviewers were asked to evaluate the forest products subprogram strategy and individual projects. The ITP peer reviewers met in a final session on April 7 to review their portfolio and project evaluations and give additional feedback to the ITP subprogram managers. A characterization of ITP's forest products portfolio and a summary of the peer reviewer's portfolio and project evaluations comprise the remainder of this report.

Portfolio Characterization

The 2006 Forest Products Peer Review included 24 projects, listed in Table 2. The projects were split up into two panels and included eight projects with funding on-going into the fiscal year 2007 (FY07) and 16 projects with funding ending in FY07. Of the 16 projects ending in FY07, seven of these projects were considered to be nearing commercialization.

	Project Title	Project Participants	Funding Status
Panel 1	Highly Efficient D-GLU Pulping	North Carolina State University, Evergreen Pulp	On-going
	Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft Cooks with Microwave Pretreatment	Oak Ridge National Laboratory	On-going
	Hemicellulose Extraction and Its Integration	University of Maine	On-going
	Improved Wood Properties Through Genetic Manipulation	North Carolina State University	On-going
	Steam Cycle Washer for Unbleached Pulp	21 st Century Pulp & Paper, LLC	Ending, nearing commercialization
	Laser Ultrasonics Web Stiffness Sensor	Institute of Paper Science and Technology	Ending, nearing commercialization
	Development and Full-Scale Demonstration of Multiport Dryer Technology	Argonne National Laboratory	Ending, nearing commercialization
	Lateral Corrugator: An Improved Method of Manufacturing Corrugated Boxes	Institute of Paper Science and Technology	Ending, nearing commercialization
	Improved Recovery Boiler Performance Through Control of Combustion, Sulfur, and Alkali Chemistry	Brigham Young University	Ending
	Performance and Value of CAD-Deficient Pine	North Carolina State University	Ending
	Development and Validation of Sterility Systems for Trees	Oregon State University	Ending
	On-Line Fluidics Controlled Headbox	Institute of Paper Science and Technology	Ending
Panel 2	Development of Renewable Microbial Polyesters for Cost-Effective and Energy-Efficient Wood-Plastic Composites	Idaho National Laboratory, Washington State University, NewPage Corp.	On-going
	Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives	University of Minnesota	On-going
	HAPs Reduction from Drying and Pressing	Institute of Paper Science and Technology	On-going
	Biological Air Emissions Control for an Energy Efficient Forest Products Industry of the Future	Texas A&M University-Kingsville, BioReaction Industries, LLC	On-going
	Fibrous Fillers to Manufacture Ultra-High Ash/Performance Paper	G.R. International, Inc.	Ending, nearing commercialization
	Development of Methane de-NO _x Reburning Process for Wastewood, Sludge, and Biomass Fired Stoker Boilers	Gas Technology Institute	Ending, nearing commercialization
	Mechatronic Design and Control of a Waste Paper Sorting System for Efficient Recycling	North Carolina State University	Ending, nearing commercialization
	VOC and HAP Recovery Using Ionic Liquids	Oregon State University	Ending
	Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites	Virginia Polytechnic Institute and State University	Ending
	An Innovative Titania-Activated Carbon System for Removal of VOCs and HAPs from Pulp, Paper, Paperboard Mills, and Wood Products Facilities with In-Situ Regeneration Capabilities	University of Florida	Ending
	On-Line Oxidation of Volatile Compounds Generated by Sawmill Wood Kilns	Mississippi State University - DIAL	Ending
	Rapid, Low Temperature Electron, X-Ray, and Gamma-Beam Curable Resins	Oak Ridge National Laboratory	Ending

The 2006 Peer Review Projects are distributed across the United States, with clustering in the Southeast and Northwest, as both regions are heavily involved in the Forest Products Industry. The map in Figure 6 shows the distribution of these projects throughout the country by location of the PI.

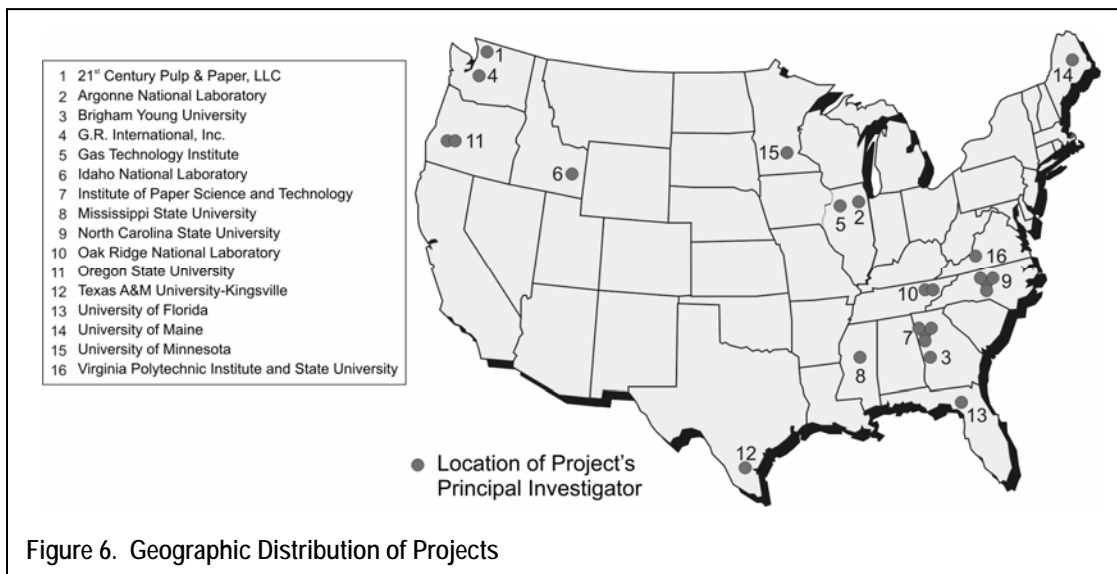


Figure 6. Geographic Distribution of Projects

The FY06 ITP forest products project funding is divided by focus area in Figure 7. In future years, ITP plans to primarily fund new projects in the Advanced Water Removal and High Efficiency Pulping focus areas. ITP will focus its funding in these two areas to develop technologies to reduce mill steam demand by 15% by 2015.

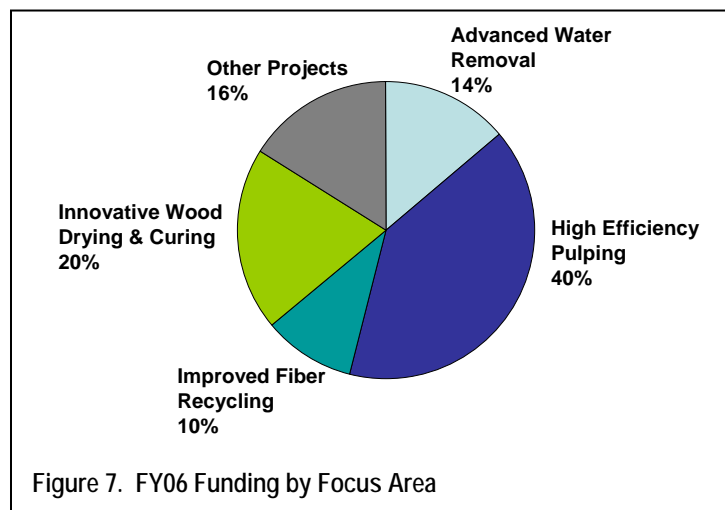


Figure 7. FY06 Funding by Focus Area

Portfolio Strategy Evaluation

ITP's Forest Products subprogram strategy, discussed in the Introduction of this report, was presented by Drew Ronneberg, ITP's Forest Products Technology Manager, at the Peer Review in the Opening Plenary Session on April 5. Prior to this session, the ITP reviewers were given a set of strategy evaluation questions; these questions and the reviewer responses are included in Appendix A. The reviewer responses to the strategy questions are summarized below.

Strategy Alignment with ITP's Mission and Objectives

The reviewers were asked if the Forest Products subprogram strategy aligns with ITP's corporate strategy of pursuing R&D in areas with high technical risk and significant energy savings potential. One of the reviewers mentioned that there is always a trade-off between investing in high risk R&D and achieving commercial success. However, given the risk adverse nature of the forest products industry, the current subprogram strategy is a good compromise. Another reviewer mentioned that funding projects with high technical risk is an appropriate role for ITP. A reviewer suggested defining technical risk as investment in technologies that offer breakthroughs, including projects that fall within the overlap between public and private benefits. Most of the reviewers supported ITP's focus on developing breakthrough technologies and avoiding R&D for mature and incremental technologies, unless they offer clear breakthroughs in energy efficiency. One reviewer disagreed due to the reluctance of the forest products industry to adopt new technologies because of the high cost of capital. For this reason, that particular reviewer suggested that ITP focus on incremental, low cost technologies to improve industrial energy intensity.

A reviewer noted the abundance of incremental projects in the current forest products portfolio. Reduced funding prevents ITP from investing in higher risk projects that can become expensive and spread out over many years. The reviewers commented that ITP's strategy to fund research in stages could allow ITP to fund higher risk projects. Staged funding enables ITP to only advance the projects that are successfully meeting their technical and other performance milestones to obtain more funding. This will enable ITP to fund innovative ideas and advance those that are technically successful and demonstrate the potential for energy efficiency breakthroughs. However, it was also noted that staged funding could delay the progress of good projects and therefore ITP should consider awarding multi-phase projects that could terminate if previously set milestones are not met.

The reviewers were also asked to provide feedback to help improve the subprogram strategy. One reviewer thought that ITP's current forest products portfolio did not include projects or pathways with the potential to reduce steam demand by 15%. Some missing areas of research that could help ITP achieve this goal include the use of alternative fuels and improving the efficiency of paper machine white water systems (e.g., reducing water use in bleach plants and interconnecting pulp and paper mill water systems). Another reviewer felt that improving evaporative water removal processes could lead to significant savings and should be considered in addition to the non-evaporative processes. Alternatives to kraft pulping were mentioned, but rejected by at least one reviewer due to the enormous technical and commercial risks involved.

General comments to improve the forest products strategy included revising the portfolio goal to encourage the development of energy efficient technologies that could lead to a self-sufficient industry based on renewable fuels and power. As energy efficiency technologies and practices are deployed, mills will use these savings to reduce their highest cost fuels. The reviewers also encouraged ITP to consider life-cycle benefits when evaluating proposals. For example, a technology that saves electricity actually saves more energy than a technology that saves natural gas due to electricity generation and transmission losses. The reviewers suggested requiring economic evaluations, developed with industry partners, in

new project proposals. Proposals should also contain clear explanations of the energy saved, highlight other benefits, and include the assumptions used to calculate the estimated savings. The development of a process to reject proposals that do not meet these criteria was also mentioned for consideration by ITP.

Strategy Alignment with the Forest Products Industry's Vision and Interests

The reviewers were asked if ITP's forest products portfolio strategy supports the industry's vision of the future. Overall, the reviewers agreed that ITP's forest products strategy aligns with the industry's vision and interests. As mentioned earlier, the reviewers stressed the need for projects to address economics. Industry is driven by economics, and energy research without deployment does not lead to energy savings. It was also noted that project partners need to be more involved with the economic analysis in order to improve the success of a project. Today, natural gas is the highest energy cost for a mill. A reviewer commented that reducing steam by 15% does not necessarily target natural gas savings because many mills use biomass and black liquor to generate steam rather than fossil fuels. However, there are some mills that do depend on natural gas to generate steam. The lime kiln is typically the largest natural gas user in most kraft mills. Hoods for Yankee and through air drying (TAD) tissue paper machines are other large natural gas consumers.

Identification and Prioritization of Focus Areas

Overall, the reviewers agreed that ITP has identified the correct focus areas for achieving significant energy savings in the forest products industry. A few of the reviewers disagreed with eliminating the wood products area as a primary focus and suggested to either be more selective with these projects by only funding high impact technologies, or to transfer them to the U.S. Department of Agriculture's (USDA) Forest Service Forest Products Laboratory. Creating an "other" focus area for public benefit projects that can enable energy savings, such as fiber recycling projects, was also suggested by a reviewer.

Technical Barriers and Goals

The reviewers agreed that ITP has identified the key technical barriers in each focus area. The reviewers also noted that the technical goals for each focus area are clear, but they disagreed on the appropriate level of technical risk for ITP funded R&D. One reviewer thought that there may be too much risk in overcoming the technical barriers because research in this field has already been "well plowed" – thereby making ITP technical goals difficult to achieve. Another reviewer brought up the risk adverse nature of the forest products industry, emphasizing that high risk, high cost technologies will not be quickly adopted by industry. Three of the reviewers felt that the technical goals for each focus area were achievable, with one reviewer pointing to the fact that bench scale equipment has already achieved 65% solids with non-evaporative paper web drying technology, while ITP's goal is 70% solids before the dryer section. The reviewers also mentioned the need for deployment assistance for some projects and suggested that ITP consider working on a deployment strategy for these technologies.

Project Evaluation

On April 5 and 6, 24 of ITP's forest products principal investigators (PIs) presented the progress and results of their technologies in two concurrent sessions. Over these two days, the ITP reviewers were split between the two panels to attend these presentations and evaluate each project. Prior to the start of the review, the reviewers were given a set of project evaluation questions that required both a written and numerical response for each evaluation criteria. The reviewers were given five criteria to evaluate each project:

1. Energy Savings and Other Benefits
2. Innovation and Technical Risk
3. Project Management
4. Commercialization Potential
5. Project Fit into the Portfolio

The reviewer evaluation written and numerical questions and reviewer responses are included in Appendix B. The reviewers' written comments on energy savings benefits respond to the PI's presentation of these benefits at the review, not the numerical scores. All of the projects in this review were chosen prior to the development of ITP's current forest products portfolio strategy discussed in this report and therefore many of the projects do not fit into this current strategy. This criterion, Project Fit into the Portfolio, will be used by ITP more in the future during Merit Reviews for new projects. The reviewers' written responses for each project are summarized below.

Panel 1 Project Evaluations

Highly Efficient Directed-Green Liquor Utilization (D-GLU) Pulping

Energy Savings and Other Benefits: The project focuses on redirecting green liquor from the lime kiln to pretreat pulp. Redirecting the green liquor reduces the load on the lime kiln and saves natural gas. The reviewers indicated that the PI's claim of 10-35% energy savings at the lime kiln was realistic.

Innovation and Technical Risk: The reviewers commented that Directed-Green Liquor Utilization is not a new technology, and Scandinavian mills in particular are already using this technology. However, the reviewers indicated that this technology has not been implemented in the United States and does have energy savings benefits and therefore is a good project for the Industrial Technologies Program. Technical risks include digester scaling and evaporator fouling.

Project Management: The reviewers ranked the project's management from average to good. One of the reviewers said the team seems to have overcome several setbacks beyond their control and now has a reasonable plan to proceed.

Commercialization Potential: The reviewers commented that this technology is simple, inexpensive to implement, and its attractiveness to industry will rise as the price of natural gas goes up. Despite economics as a driving factor, the project team's commercialization plans were not clear. In particular, it was not clear to the reviewers how this technology, if successful, will be implemented across the industry. A reviewer commented that the project team should be encouraged to quickly publish the mill results, even if the results are negative. If the mill trials are successful, perhaps DOE could work with the project team to publish a case study for this technology.

Project Fit into the Portfolio: The reviewers all agreed that this project is a good fit for ITP's Forest Products portfolio. One reviewer mentioned that this project is an example of the type of project that should receive priority from ITP since it is based on understood technology that can be implemented at a low cost to the end-user and ITP with a potential for substantial energy savings.

Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft cooks with Microwave Pretreatment

Energy Savings and Other Benefits: The project investigates microwave pretreatment of wood chips to improve the energy efficiency of chemical pulping. The PI's energy savings benefits were generally thought to be optimistic by the reviewers. The PI estimated that the consumption of pulping chemicals could be reduced by 40%, whereas the reviewers thought that 20% was more likely. The energy savings benefits are due to the fact that the reduction of pulping chemicals means that there is less lime mud that needs to be causticized during chemical recovery. Lime mud is causticized in a lime kiln fired by natural gas. The PIs also questioned the likelihood that a RF level of 5 MW would be sufficient for all wood chip conditions and some reviewers questioned how widely applicable the technology would be across industry.

Innovation and Technical Risk: The project was viewed as innovative and capable of providing significant changes to pulp manufacture. One reviewer questioned whether a significant literature review had been conducted because microwave pretreatment had already been investigated in the 1970s. The benefits of the technology would come with the downside of having to install and operate a technology for which the forest products industry does not have experience. In addition, in operating conditions, metal objects would have to be screened because they could damage the RF applicator.

Project Management: The reviewers thought the project management had sufficient expertise to conduct the research, but thought that the project had been making slow progress. One reviewer thought the project should attempt to scale up the operation to demonstrate the technology at a scale that would interest mills. One reviewer thought the work devoted to the hemicellulose extraction from black liquor did not fall under the scope of work and should be part of a separate project.

Commercialization Potential: The reviewers thought the project had targeted the right technical challenge for demonstrating the technology on a mill-scale – using the microwave pretreatment to treat oversize chips. The project needs to have a strong industrial partner that understands the microwave technology and must ensure that the pre-treatment is uniform for all wood chips. If successful, the pre-treatment of oversize wood chips produces fewer fines and increases pulp yields.

Project Fit into the Portfolio: The project fits into the portfolio and primarily addresses the usage of natural gas consumption in the lime kiln. It will also reduce steam demand by lowering pulping energy requirements.

Hemicellulose Extraction and Its Integration

Energy Savings and Other Benefits: The projects seeks to extract hemicelluloses from wood prior to pulping to increase pulp yield by adsorption on the pulp fibers after cooking. The reviewers agreed that the project has potential for chemical and energy savings. One reviewer commented that removing 25% of hemicellulose will reduce recovery boiler load and permit capacity increases in many mills. Reviewers also noted that this is an enabling technology for the future biorefinery. One reviewer also commented that this technology will impact only a few plants and will not produce technologies that are easily implemented.

Innovation and Technical Risk: The reviewers all ranked this project as transformational; however, a reviewer remarked that the concept of extraction and redeposition of hemicellulose is well known.

Technical risks and barriers exist but none of them are well enough understood to allow use of this technology without further research and development. The reviewers had a few questions including how much lignin is present in the hemicellulose extraction and how it will be recovered and used. The reviewers also noted that if the hemicellulose extract is used for the production of value added chemicals, rather than redeposition, the extract will need to be concentrated from 8% to 12-16%. Others have failed in concentrating weak hemicellulose solutions with evaporation and therefore, it will be difficult to recover the hemicellulose fraction that is not absorbed.

Project Management: The reviewers rated the project plan as average for delivering the plan's objectives.

Commercialization Potential: The project's commercial partner has interest in increasing capacity at recovery limited mills and if the technology is successful, a yield increase will attract paper companies. Using hemicellulose extraction to increase pulp yield has the potential for commercialization. However, a reviewer found that the project's plan to bring in a partner to commercialize the polymer creation portion of this project was unclear.

Project Fit into the Portfolio: Two of the reviewers felt that the project fits into ITP's forest products strategy and has good potential to reduce energy and create new products. The other reviewer felt that the project enables the biorefinery but does not fit well into the strategy of reducing steam demand.

Improved Wood Properties Through Genetic Manipulation

Energy Savings and Other Benefits: The project focuses on genetic manipulation of softwoods to incorporate a type of lignin found in hardwoods, syringyl lignin, into their structure. Syringyl lignin is less resistant to chemicals and therefore easier to pulp. Incorporating syringyl lignin into softwoods promises to reduce the energy, chemicals, and bleaching required for chemical pulping. Although the energy savings opportunity is significant, the reviewers agreed that it will take a long time before transgenic trees will be large enough to harvest.

Innovation and Technical Risk: The project was viewed as highly innovative and risky enough to justify government support. The public's opposition to genetically modified organisms might prevent these trees from being used.

Project Management: The reviewers thought the project was well managed and has produced excellent results.

Commercialization Potential: While the commercialization of this technology is still a number of years away, industry support for this project is strong because it will help U.S. industry compete with low cost wood from cloned forests in the Southern Hemisphere. One reviewer encouraged the team to put together a commercialization plan.

Project Fit into the Portfolio: The project would be a better fit in a portfolio that was more forestry focused rather than manufacturing focused. The Department of Agriculture was suggested as an alternative funding source.

Steam Cycle Washer for Unbleached Pulp

Energy Savings and Other Benefits: The project seeks to demonstrate a steam-pressurized, high consistency pulp washer. This technology will use less water than conventional washers, which will reduce the amount of water that has to be evaporated from black liquor in the chemical recovery process. The PI's energy savings benefits were generally thought to be optimistic by the reviewers. The PI compared the benefits of the steam cycle washer to older technology (drum washers) rather than state-of-

the-art wash presses, which already achieve 28-30% solids. For accurate impact projections, the steam cycle washer should be compared to more advanced, currently available technology. The steam cycle washer is a batch process whereas the more efficient mills use continuous digesters. Introducing a batch process into a continuous system could limit the mill's performance. The steam cycle washer is being developed for Port Townsend, which is an older, less efficient mill and therefore does not make a good basis for comparison for general application across the paper manufacturing industry. If the steam cycle washer proves to be successful at Port Townsend, the technology would find a few other applications at older mills, similar to Port Townsend that have small batch digesters. However, if the cost of the steam cycle washer is significantly less than wash presses (~50% less) then this technology could be more widely applicable and have higher energy impacts.

Innovation and Technical Risk: The steam cycle washer is a new, innovative technology for the industry with technical risks that provide an opportunity for government funding. The technology would replace existing washer/press designs, which are numerous. Achieving the 28% consistency in real time at commercial production rates is the key to success. The steam cycle washer's complexity must be proven over time in a production operation as sustainable at high process efficiencies. The equipment appears to be complicated and therefore might be difficult to maintain in a mill environment. In addition to possible maintenance issues, the effect on pulp quality and its impact on various paper grades may also be an issue that could limit the applicability of this technology. A general comment from one of the reviewers was that not enough time was spent up front figuring this technology out.

Project Management: The reviewers thought that the project management is satisfactory to excellent and noted that the project manager has experience with similar equipment. One of the reviewers commented that a Cooperative Research and Development Agreement (CRADA) should be put in place and that the timeline for this technology may be optimistic. The reviewer noted that technology validation will require more than two quarters and the technology will not achieve commercial acceptance until it is well proven in a commercial demonstration.

Commercialization Potential: If the commercial demonstration at Port Townsend is successful, economics will drive the market penetration since there are a large number of competing technologies already commercially available. One reviewer noted that it will take the project team a year or two to work out the bugs at Port Townsend. The design of the steam cycle washer is mechanically complex and its impact on pulp characteristics may limit the technology's commercial impact. The project team did a good job positioning the technology for commercialization in the state of Washington.

Project Fit into the Portfolio: The project fits into the portfolio and addresses energy reduction and water resource conservation. The steam cycle washer appears to define one of ITP's forest products pathways, placing a "big bet" on this technology related to the success of the pathway.

Laser Ultrasonics Web Stiffness Sensor

Energy Savings and Other Benefits: The reviewers agreed that this project is not an energy driven project; however it is expected to result in some energy savings. Successful on-line measurement of paper mechanical properties will enhance the paper machine process and quality control and increase paper machine efficiency.

Innovation and Technical Risk: Despite the incremental energy savings, the paper physics involved in this project as well as the laser-ultrasonic method and mathematical conversion of information allowing non-contact measurement represent a novel, breakthrough concept.

Project Management: The reviewers commented that the project seems to be currently well organized; however, they also noted that the project had some scheduling issues in the past. The project results going forward will be determined by the commercial partner.

Commercialization Potential: With a firm commitment from the commercialization partner (ABB), this project has a good chance of commercialization if it functions well technically. The reviewers mentioned that industry will adopt this technology fairly quickly as capital becomes available, and economics will drive adoption.

Project Fit into the Portfolio: The project does not fit into ITP's current portfolio strategy.

Development and Full-Scale Demonstration of Multiport Dryer Technology

Energy Savings and Other Benefits: The Multiport dryer focuses on increasing paper drying rates by reducing the thermal resistance of the condensate layer that forms on the inside surface of a conventional paper drying cylinder and increasing steam flow velocity in the cylinder to enable heat transfer by convection. The Multiport dryer, a retrofitable technology, promises to allow paper makers to reduce their energy intensity by either increasing paper productivity or reducing steam pressure (energy savings). The reviewers agreed this technology will save energy but disagreed on the quantity ranging from 3 trillion Btu per year to over 10 trillion Btu per year. One of the reviewers mentioned that compared to spoiler bar equipped dryers, the Multiport dryer will save approximately 20% energy by allowing lower pressure steam operation. If pilot testing proves positive, the reviewers generally agreed that this technology would be attractive to a number of mills, particularly older mills, and could be implemented in a short timeframe.

Innovation and Technical Risk: The reviewers agreed that the Multiport dryer project innovation is substantial. One of the reviewers commented that this project is excellent for ITP investment. Technical risks related to hardware limitations and other problems that might arise during high-pressure trials will need to be overcome prior to commercial use.

Project Management: Two of the reviewers commented that the project appears well managed and that the project plan is good for delivering objectives. The other reviewer thought the project plan was average.

Commercialization Potential: The reviewers agreed that the project's potential for commercial success is likely (greater than 50%). The reviewers commented that successful commercialization will depend on heavy involvement by an equipment supplier knowledgeable in paper drying applications. Kadant Johnson is a key player in the paper drying market, has the economic incentive to commercialize the Multiport dryer, and has the technical marketing and sales network to accomplish commercialization.

Project Fit into the Portfolio: Two of the reviewers felt that this project meets ITP's mission to reduce steam demand, especially in existing mills with older, less efficient drying technology. One of the reviewers commented that this technology will not have a significant impact on steam reduction.

Lateral Corrugator: An Improved Method of Manufacturing Corrugated Boxes

Energy Savings and Other Benefits: The Lateral Corrugator is a box manufacturing method that places the linerboard parallel to the flutes of the corrugating medium. Lateral corrugation improves the compressive strength to weight ratio of corrugated shipping containers and reduces linerboard trim waste. Both of these advantages promise to reduce fiber consumption and energy use for corrugated box manufacturing. The reviewers all agreed that the Lateral Corrugator technology has an energy savings potential greater than or equal to five trillion Btu per year.

Innovation and Technical Risk: The reviewers rated this project's innovation as substantial to transformational. Sheet generation and positioning concepts are used in other industrial applications, and the novelty of the Lateral Corrugator lies within its application in corrugating and creating a viable process. The technology is seen as transformational in the sense that once one company uses this technology, the others will follow, changing the basic box design. Technical risks related to issues with glue machines need to be resolved. Also, a reviewer commented that this project was initially very risky, yet this risk has been reduced by the project team.

Project Management: The project team appears to be functioning well and substantial collaboration exists with parties interested in the commercialization of the concept. The reviewers agreed that this project has a good plan for delivering its objectives.

Commercialization Potential: The reviewers all agreed that commercial success is probable for the Lateral Corrugator (greater than 80%). Technical feasibility is good and business conditions are favorable for widespread implementation. Economics and the superior box product should drive adaptation once pilot operation is demonstrated. End users and equipment suppliers are involved in the project and contributions indicate commitment; however, one of the reviewers did not get a sense that anyone was in charge of commercialization of this technology. The reviewers commented that IPST at GeorgiaTech might not be the right group to commercialize this technology, and a partner should take the lead.

Project Fit into the Portfolio: The reviewers agreed that the project fits a key technical barrier and is practical for ITP's forest product portfolio; however the technology does not save steam directly or address specific pathways in the current strategy.

Improved Recovery Boiler Performance Through Control of Combustion, Sulfur, and Alkali Chemistry

Energy Savings and Other Benefits: The project focuses on experimental and modeling tasks to improve the design and operation of kraft recovery boilers to maximize energy and operational efficiency. The project's energy savings are modest and most economic benefits will result from implementation on new boilers. The reviewers all rated this project's energy savings potential greater than or equal to one trillion Btu per year. One reviewer also suggested that the PI look into using his expertise to improve black liquor gasification.

Innovation and Technical Risk: The reviewers rated the innovation as incremental; the knowledge generated by this project can be used to improve recovery boiler design and operation. However, the reviewers noted that the experimental work is innovative and the research adds significantly to boiler knowledge. The reviewers characterized the project as basic science research and therefore technically risky; however, the science must be developed to improve the black liquor combustion process.

Project Management: The reviewers agreed that the project has a good plan for delivering the objectives. Specifically, the reviewers praised the project team's expertise, project management, and execution of research.

Commercialization Potential: The potential for commercialization of this project is low since knowledge is the key result. The reviewers commented that the knowledge generated by this project is useful to the industry and if used, would primarily apply to new boiler designs. The reviewers also believed that some of the concepts developed in this project could also be applied to improving gasifiers.

Project Fit into the Portfolio: The reviewers agreed that this project fits into ITP's steam reduction strategy but does not address any of the pathways identified in the priority focus areas. The reviewers

also commented that the impact of this project is low, but the research and knowledge generated is a good improvement for the industry.

Performance and Value of CAD-Deficient Pine

Energy Savings and Other Benefits: The project focuses on developing breeding programs for trees that are CAD deficient. CAD is the enzyme that catalyzes the last step in the biosynthesis of lignin precursors. CAD-deficient trees promise improved wood/fiber traits that will reduce energy consumption in forest products manufacturing processes. The reviewers scored the energy savings potential as low for this project and one reviewer mentioned that this project should not be justified on an energy savings basis.

Innovation and Technical Risk: The reviewers rated the innovation on this project as incremental. One of the reviewers mentioned that ecology guidelines may restrict application of a breeding program for the CAD-deficient trees.

Project Management: The reviewers rated the project's plan from average to good for meeting its objectives. One reviewer mentioned there were no issues in the project management and another commented on the thorough project plan and implementation.

Commercialization Potential: Two of the reviewers thought the probability of commercial success for this project was likely (greater than 50%) and the other reviewer thought it was not likely (less than 30%).

Project Fit into the Portfolio: The reviewers agreed that this project no longer fits into the scope of ITP and should be funded by the Department of Agriculture rather than the Department of Energy.

Development and Validation of Sterility Systems for Trees

Energy Savings and Other Benefits: The goal of this project is to develop and validate sterility in poplar trees. The success of this project would help to enable industry's use of genetically engineered trees to increase productivity, reduce environmental impacts from pulping, and improve energy efficiency. This project does not directly save energy and therefore energy savings outcomes are speculative.

Innovation and Technical Risk: The reviewers agreed that the innovation of this project is substantial and noted that the social acceptance of this technology is questionable. The reviewers commented that the technical risk is high and the technology would need to be applied to other tree species to impact the industry.

Project Management: The reviewers commented that the project's plan is average for delivering the objective and that the project appears to be well managed.

Commercialization Potential: The reviewers rated the potential for commercial success as low.

Project Fit into the Portfolio: The reviewers agreed that this project no longer fits into the scope of ITP and should be a project funded by the Department of Agriculture rather than the Department of Energy.

On-Line Fluidics Controlled Headbox

Energy Savings and Other Benefits: The project focuses on using a new technology, microforming, in a headbox to improve the structural formation of the paper sheet and create a better paper product. This technology is thought to reduce rejects and papermaking costs while increasing paper machine

productivity. The reviewers agreed that the energy savings potential for this project is equal to or greater than one trillion Btu per year.

Innovation and Technical Risk: The reviewers rated the innovation for this project as substantial. For this project to succeed, the application of fluid dynamics, suspension hydrodynamics, paper physics, and instrumentation must be combined. The reviewers commented that the project is also technically risky and can not really be justified based on energy savings.

Project Management: The reviewers thought that the project's plan was from average to good for delivering its objectives. The project team seems to be well managed and is solving problems as they arise.

Commercialization Potential: The reviewers commented that the probability for commercial success ranged from in jeopardy to likely. One reviewer remarked that a well thought out commercialization plan was missing from this project and another noted that the PI appears to lack the skills or interest to commercialize this technology. A reviewer mentioned that there will be a limited application for this technology due to the age and condition of many headboxes on U.S. machines and the fact that this technology will be expensive to install. Also noted was that this may be a good technology but needs the support of a major paper machine supplier and all of the major paper machine suppliers are headquartered outside of the United States.

Project Fit into the Portfolio: The reviewers questioned this project's fit into ITP's current forest products portfolio, mainly due to the insignificant energy impacts. One reviewer rated the project as not fitting into the portfolio and the other two reviewers thought the project fit into the portfolio and addresses one of its key technical barriers.

Panel 2 Project Evaluations

Development of Renewable Microbial Polyesters for Cost-Effective and Energy-Efficient Wood-Plastic Composites

Energy Savings and Other Benefits: The project seeks to develop a cost-effective means of using unpurified, renewable, and biodegradable polyhydroxyalkanoates (PHAs), or microbial thermoplastic polyesters, produced from waste effluents to create wood-plastic building materials. The PI's energy savings benefits were generally thought to be optimistic by the reviewers. The energy savings calculations assumed that bacterial-derived PHAs would displace petroleum-derived polymers in engineered wood products, but the energy required by the processes to produce the PHAs is not sufficiently documented. In addition, the potential market for PHA production for the pulp and paper industry was smaller than claimed because not all mills have activated sludge processes.

Innovation and Technical Risk: The project was viewed as innovative and could provide a high value product from a current waste stream. The technical risk is also high as there are many unknowns surrounding the project including the strength of wood composites with unpurified PHAs. One reviewer commented that the property testing aspect of the project appeared to be very good.

Project Management: The reviewers thought that the project had a strong team and sufficient expertise to conduct the research. They also thought that the revised milestone schedule was appropriate. One reviewer commented that there should be a commercialization partner who could play a more prominent role in the research effort.

Commercialization Potential: Because the project is in an early stage of research, the reviewers thought it was difficult to properly assess the project's commercialization potential, and there was a wide divergence of opinion on the likelihood that the technology would be commercialized. One reviewer commented that bio-based polymers have had a hard time achieving market acceptance. Another reviewer thought that if the technology could be proven technically, mills would have a strong incentive to implement the technology. The reviewers thought that the chances that a commercializable technology could be produced would be increased with greater involvement by Strandex. The commercialized technology would also need to overcome potential fears that the material was derived from pulp mill waste or sewage waste.

Project Fit into the Portfolio: The project is the only one in the forest product's portfolio that primarily saves petroleum, so it supports DOE's broader energy savings mission, but doesn't directly address ITP's forest product goal of steam reduction. One reviewer commented that the project might be a better fit for a bio-products based portfolio.

Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives

Energy Savings and Other Benefits: The goal of this project is to design new formulations and production processes for water-based adhesives and wax coatings that can be easily screened from recycling operations. The stated energy savings benefits were based on numbers that AF&PA claimed for recycling. Because the reviewers did not know how the AF&PA energy savings numbers were calculated, they found it difficult to measure the energy savings impact of this project. The reviewers thought that the PI should recalculate the energy savings numbers based on the benefits specific to this project.

Innovation and Technical Risk: The project was viewed as innovative and could provide significant benefits if the technology is commercialized. The reviewers thought that the PI had a well thought out plan for developing and testing screenable water-based pressure sensitive adhesives and wax coatings.

Project Management: The reviewers thought that the project had an outstanding team and sufficient expertise to conduct the research. One reviewer suggested that since wax corrugated boxes goes to a specific type of recycling mill, a paper mill should be involved as an industrial partner.

Commercialization Potential: The reviewers commented that even with a successful technology, this project will have unusual challenges to commercialization because the technology benefits the recycle paper industry rather than the adhesive/wax manufacturing industry that would implement the technology. A similar problem was addressed by the same team when they partnered with several adhesives makers to commercialize a screenable hot-melt PSA. One reviewer encouraged the PI to seek an executive order from the federal government to purchase screenable waxes/PSA to help jump start the market.

Project Fit into the Portfolio: The project does not save steam, but the reviewers felt that the project would fit in the portfolio if the PIs could document significant energy savings.

HAPs Reduction from Drying and Pressing

Energy Savings and Other Benefits: The project will save energy by replacing the need to destroy volatile organic compounds (VOCs) in a natural gas-fired Regenerative Thermal Oxidizer (RTO) with process changes that reduce VOC generation. These changes include altering the knife angle on the chippers and screening out fines before the wood is dried. Although the gas savings will be significant, the original estimates were based on the assumption that the VOC regulatory requirements would be stricter than was implemented in the final rule. Because this technology requires only minor process changes, they can achieve rapid market penetration.

Innovation and Technical Risk: The project was viewed as highly innovative as the research elucidated the key factors which determine VOC generation from wood (overdrying of fines). One reviewer also noted that the researchers should complete their plans to investigate a polymer application that can reduce the formation of formaldehyde.

Project Management: The reviewers thought that the project was well managed and complemented the team on their close working relationship with industry. One reviewer reiterated that the team's energy savings estimate should be recalculated.

Commercialization Potential: The reviewers commented that several of the project's objectives have produced results that have already been implemented (adjustment of knife angle and fines screening) by their immediate industrial partners. As the technologies are low cost and produce significant benefits, there aren't significant barriers to commercialization. However, because there isn't a vendor to commercialize the technology, knowledge will have to be spread through alternative means like the American Forestry and Paper Association.

Project Fit into the Portfolio: The project fits into the portfolio and will reduce natural gas usage in the Forest Products industry. It is a classic example of how process changes can obviate the need for end-of-the-pipe control technologies.

Biological Air Emissions Control for an Energy Efficient Forest Products Industry of the Future

Energy Savings and Other Benefits: The project focuses on developing a VOC treatment system that uses microorganisms to degrade air toxins without the use of natural gas as fuel or the creation of secondary pollutants. The energy savings benefits of this technology are in comparison to Regenerative Thermal Oxidizers (RTOs) which incinerate dilute streams of VOCs and consume large amounts of natural gas. While the technology may be applicable to a number of industries, one reviewer questioned how many RTOs would be shut down by this technology. It may be more likely that the biological treatment would be installed as RTOs wear out.

Innovation and Technical Risk: The concept of treating VOC emissions through biological degradation has been around for a number of years and the technology has steadily improved. The reviewers viewed the technology and the remaining barriers as fairly well understood, and that this research project was addressing the remaining barriers preventing commercialization of the technology. Of all the potential VOC mitigation technologies that could compete with RTOs, the biological treatment was viewed as the most likely to reach commercialization.

Project Management: The reviewers thought that the project had an outstanding team and sufficient expertise to conduct the research and push the technology through to commercialization. The team is making good progress toward its objectives.

Commercialization Potential: The reviewers thought that the project had a good chance of being commercialized after the positive results during mill trials at Stimson Lumber. One reviewer commented that the market for the technology is currently uncertain, while another reviewer thought that the technology had achieved its performance criteria and may not require further DOE funding to achieve commercialization.

Project Fit into the Portfolio: The project reduces natural gas consumption in the forest products industry and is a good fit into the portfolio. The reviewers encouraged ITP to compare RTO alternatives and select the most promising ones for commercialization assistance.

Fibrous Fillers to Manufacture Ultra-High Ash/Performance Paper

Energy Savings and Other Benefits: The project has developed inorganic paper fillers that can replace up to 50% of the high-cost wood fiber used in paper manufacturing, while maintaining critical paper properties and reducing energy use. The energy savings benefits result from displacing wood fiber and increasing the percentage of solids in the sheet after the press section. All reviewers thought that the energy savings estimates were conservative and that the PI did a good job of quantifying these benefits.

Innovation and Technical Risk: The project was viewed as highly innovative and could significantly change the pulp and paper industry by replacing much of the wood fiber in a sheet with filler. One reviewer noted that the PI started a company to develop the fibrous fillers concept and has much at stake to insure that the project is successful. Another reviewer thought that DOE should consider what could be done with the mills that would be shut down if this project is successful because of reduced demand for pulp. The reviewer suggested that these mills could be converted into biorefineries.

Project Management: The reviewers thought that the overall project was well-managed technically, but that there should be more industry involvement. A few milestones were missed. One reviewer pointed out that mills do not build and operate PCC plants, and that PCC operators would likely have little interest in fibrous fillers because it is a competing technology.

Commercialization Potential: The commercialization of this technology will require partners/licensees with the ability to make large capital investments. One reviewer thought that the current lack of industry involvement and interest is hurting the prospect for commercialization and that the results from the Gray's Harbor mill trial need to be disseminated more widely.

Project Fit into the Portfolio: The project reduces steam demand and supports the ITP goal of steam reduction.

Development of Methane de-NO_x Reburning Process for Wastewood, Sludge, and Biomass Fired Stoker Boilers

Energy Savings and Other Benefits: METHANE de-NO_x® (MdN) is a reburning process that improves the combustion of solid waste fuels while controlling NO_x and CO emissions in stoker boilers. The energy savings benefits of this technology result from increased boiler efficiencies due to more complete combustion. The MdN technology also has significant environmental benefits because it reduces NO_x emissions from boilers. One reviewer thought that the potential market size was smaller than what the project reported.

Innovation and Technical Risk: The MdN concept has been used for a number of years and the process of applying the technology is fairly well understood. One reviewer commented that the technology has been installed in enough installations that the initial risk of the project has been overcome. Another reviewer commented that Paprican has developed a competing technology that might be superior to the MdN process and that this competing technology would soon be available for U.S. mills.

Project Management: The reviewers thought that the project had a competent team and has made progress in the R&D and commercial demonstrations. One reviewer thought that the technology currently lacked an industrial champion, while another reviewer thought that the team should have been aware of the competing Paprican technology.

Commercialization Potential: There was disagreement among the reviewers as to the project's commercialization potential. Two reviewers mentioned that the technology has had commercial installations for some time and will have to compete with the highly regarded Paprican technology. One

reviewer thought that the team had paid insufficient attention to permitting questions. Another reviewer thought that the team had a good commercialization strategy, but that the technology no longer needed DOE support.

Project Fit into the Portfolio: The project reduces natural gas consumption in the forest products industry and increases steam production. It is a good fit for the portfolio and is best characterized as a combination of increased energy efficiency and fuel substitution.

Mechatronic Design and Control of a Waste Paper Sorting System for Efficient Recycling

Energy Savings and Other Benefits: The project has been developing lignin and stiffness sensors for automated, on-line waste paper sorting systems. The energy savings benefits are indirect and come from a higher utilization of the waste paper stream by utilization of this sensor technology. The reviewers agreed that the energy savings were fairly small, but one reviewer thought they were larger than what the PI stated. One reviewer thought there were also large public benefits from increasing the quality of recycled fiber because it would increase recycling rates.

Innovation and Technical Risk: The project was viewed as a highly innovative approach for better paper grade separations. The team has already successfully commercialized a lignin sensor at a few full-scale recycling facilities and the likelihood of this technology being successful is high. One reviewer thought the team might not be taking maximum advantage of existing technology and methods.

Project Management: The reviewers thought the project was well-managed, had a good team, and was making good progress toward achieving its milestones.

Commercialization Potential: The reviewers noted that parts of the project had already been commercialized and thought that the stiffness sensor was likely to be commercialized through similar channels.

Project Fit into the Portfolio: The project does not reduce natural gas or steam demand. Its value is increasing the amount of recycled fiber and improving the quality of the fiber.

VOC and HAP Recovery Using Ionic Liquids

Energy Savings and Other Benefits: The project investigates the use of ionic liquids as a method to capture organic compounds from air. The energy savings benefits of this technology are in comparison to Regenerative Thermal Oxidizers (RTOs) which incinerate dilute streams of VOCs and consume large amounts of natural gas. While the technology may be applicable to a number of plants, one reviewer questioned how many RTOs would be required by new environmental regulations.

Innovation and Technical Risk: The project is a novel approach to separating VOCs, but fundamental aspects of the technology are poorly understood. One reviewer thought that lifecycle energy and environmental impacts were not adequately addressed and that other approaches to VOC mitigation would likely prove more attractive. Another reviewer pointed out that the ionic liquids approach has not yet achieved results that can meet EPA regulations, but that more R&D could make the technology viable.

Project Management: The reviewers were concerned that the project did not have adequate involvement of industrial partners even though there were industrial partners as part of the team. One reviewer thought that the team was well focused toward achieving the project objectives. Another reviewer thought that the process' desorption step would not work well enough to enable a commercialized technology.

Commercialization Potential: The reviewers thought that the commercialization potential of the technology was low because other emerging technologies were further along in their development and appeared to be better suited to replacing RTOs. Factors like ionic liquid cost and degradation could make the process uneconomic. In addition, one reviewer felt that a company would not want to use the technology without a much longer track record of meeting EPA standards. Another reviewer thought that the team was relying too much on commercialization partners to resolve issues surrounding the technology.

Project Fit into the Portfolio: The project reduces natural gas consumption in the forest products industry and addresses a similar problem to approximately five other technologies. The reviewers thought that these technologies should be compared and the most successful ones continued.

Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites

Energy Savings and Other Benefits: The project seeks to develop an isocyanate-reactive adhesive that cures at room temperature. The energy savings benefits of this technology result from a reduction in the energy required to cure isocyanate wood resins in comparison to phenol-formaldehyde adhesives. The reviewers thought the energy savings would be substantial, but the specific assumptions and types of energy should be more thoroughly discussed in the project team's written and oral presentations.

Innovation and Technical Risk: The reviewers disagreed about the project's level of innovation and technical risk. One reviewer thought the project had a systematic approach to addressing the project's objectives, but that the project's level of innovation was low. The other reviewers' comments concentrated on potential technical issues that would have to be overcome for the isocyanate adhesives to be commercially successful.

Project Management: The reviewers thought the project team was very well qualified to achieve the objectives. One reviewer commented that the project team was well organized to address the major commercialization barriers. Another reviewer thought the inclusion of Weyerhaeuser on the project team helped the commercialization prospects. The third reviewer commented that there should be more work on understanding the capital and operating costs of a potential new process.

Commercialization Potential: The reviewers thought there were significant technical issues standing in the way of commercialization. In addition, two reviewers commented that it would make more sense if the technology was commercialized in a greenfield plant that could be designed from scratch to handle the new adhesives. The requirement for greenfield plants could slow the introduction of the technology.

Project Fit into the Portfolio: The project reduces steam demand and natural gas in the forest products industry, and is thus a good fit into the Forest Products (FP) portfolio.

An Innovative Titania-Activated Carbon System for Removal of VOCs and HAPs from Pulp, Paper, Paperboard Mills, and Wood Products Facilities with In-Situ Regeneration Capabilities

Energy Savings and Other Benefits: The project focuses on developing a titania-coated carbon system for removing VOCs and hazardous air pollutants (HAPs) from air streams. The energy savings benefits of this technology are in comparison to Regenerative Thermal Oxidizers (RTOs) which incinerate dilute streams of VOCs and consume large amounts of natural gas. The team claimed very modest energy savings in the pulp and paper industry. One reviewer commented that the technology had the ability to remove other pollutants besides VOCs and HAPs and might have better markets outside of the pulp and paper industry.

Innovation and Technical Risk: The reviewers disagreed about the project's level of innovation. Two reviewers thought that the project took a novel approach to VOC mitigation, while one reviewer commented that the project's technical risk was not high. The same reviewer pointed out that the team failed to address the attrition issue. In addition, one of the reviewers thought that the PI glossed over some important issues related to the technology.

Project Management: The reviewers generally thought that the team was capable of carrying out the research. One reviewer commented that the team was well placed for commercializing the technology, especially outside of the pulp and paper industry. One reviewer thought that a pulp and paper mill should be involved. Another reviewer thought that important objectives had been met, but more work needed to be performed in order to commercialize the technology.

Commercialization Potential: There was disagreement among the reviewers about the technology's commercialization potential. Two reviewers thought that the technology had a good chance of being commercialized outside of the pulp and paper industry. The other reviewer thought that technology did not seem ready for commercialization because it had serious performance and scale-up issues that needed to be addressed.

Project Fit into the Portfolio: The project reduces natural gas consumption in the forest products industry and addresses a similar problem to approximately five other technologies. The reviewers thought these technologies should be compared and the most successful ones continued.

On-Line Oxidation of Volatile Compounds Generated by Sawmill Wood Kilns

Energy Savings and Other Benefits: The project seeks to develop an oxidation process that utilizes ultraviolet light and hydrogen peroxide to reduce lumber drying kiln emissions. The energy savings benefits of this technology result are in comparison to RTO VOC mitigation. One reviewer thought that because the technology was being applied to market segments that did not require VOC mitigation, there are not any real energy savings. Another reviewer said that the PI did not provide energy savings estimates.

Innovation and Technical Risk: The reviewers thought the project was beset by considerable technical problems and should have been pursued on a smaller scale before building larger prototypes. One reviewer thought the project wasn't worth doing because it wasn't addressing an issue that is currently a problem for the targeted portion of the pulp and paper industry.

Project Management: The reviewers thought the project team was incomplete and had missed important milestones. There was a general consensus that the technology would not be technically successful even with additional funding.

Commercialization Potential: The reviewers thought the project did not have a compelling market or a successful technology to address the VOC mitigation market.

Project Fit into the Portfolio: The project could potentially reduce natural gas usage, but the reviewers thought it was a poor fit for the portfolio because it was unlikely that the project would be successful.

Rapid, Low Temperature Electron, X-Ray, and Gamma-Beam Curable Resins

Energy Savings and Other Benefits: The project focuses on developing resin systems that reduce wood composite curing temperatures. The energy savings benefits result from curing resins at lower temperatures. The project can save a significant amount of steam when the presses or dryer are steam driven. One reviewer thought that the actual energy savings might be lower than claimed because technology might not be applied to all market segments.

Innovation and Technical Risk: The project has developed an innovative way of reducing the curing energy for wood resins which could be transformational for the wood products industry. The reviewers thought that the project had overcome a number of technical barriers and could produce a commercially viable technology.

Project Management: The reviewers thought that the project had a strong team and complemented them for involving two industrial partners. The project had a systematic research approach and a good plan for disseminating the research results to potential end users. One reviewer thought that roles of participants and intellectual property issues could have been presented more clearly.

Commercialization Potential: The reviewers disagreed about the project's commercialization potential. One reviewer thought that after the first commercialization partner joined the group, the technology would likely be rapidly adopted. Another reviewer thought that the path to commercialization was unclear.

Project Fit into the Portfolio: The project reduces steam demand and natural gas usage and is a good fit for the ITP portfolio.

Reviewer Recommendations

Portfolio Recommendations

Based on ITP's Forest Products subprogram strategy presentation and subsequent strategy discussions, the following is a summary of the reviewers' recommendations:

- The Forest Products subprogram should clearly define technical risk. This definition should clarify that technical risk will vary depending on the stage of the research. Lower stage projects should have higher risk, higher stage projects should have lower technical risk, and commercialized technologies should be low risk to industry for adoption.
- ITP should consider restructuring its forest products strategic message to de-emphasize black liquor gasification and the forest products biorefinery. Both of these topics are not yet fully supported by the forest products industry. An alternative goal could focus on making the forest products industry self-sufficient, depending on renewable energy for fuel and power.
- The potential for ITP's current forest products portfolio to reduce steam demand by 15% by 2015 is low. Some of the missing areas of research include the use of alternative fuels and improving the efficiency of paper machine white water systems. Rather than focusing on steam, ITP should concentrate in areas where natural gas is used (e.g., lime kilns, evaporative drying processes, etc.). Additional areas could also be identified by the new industry roadmap that Agenda 2020 is currently finalizing. ITP should carefully review these opportunities in structuring its future project solicitations.
- The forest products industry is reluctant to adopt new technologies due to the high cost of capital. To overcome this, the Forest Products subprogram should work closely with ITP's Technology Delivery program to deliver best practices to mills that could enable them to save energy with little to no capital investment.
- ITP should either use an "other" focus area or work with other government offices to transfer important, high impact research such as the tree genetics, wood products, and fiber recycling projects.
- ITP should implement its strategy to fund research in stages but consider awarding early multi-stage projects that require detailed reviews to move on to the next stage. Multi-stage projects will enable ITP to terminate unsuccessful projects without slowing the progress of successful projects. However, higher stage projects (stage 4 and 5) should not be multi-stage, as these must undergo rigorous reviews to ensure that the energy impacts are significant, technical risk is acceptable, and the economics will drive industry adoption.
- The Forest Products subprogram should impose strict requirements for accepting and awarding proposals. ITP should require economic evaluations tailored to the project stage; higher stage projects should have more detailed evaluations. Proposals should also contain clear explanations of all of the technology benefits (e.g. economics, energy, etc.) and the assumptions used to develop these benefits. A process for rejecting proposals that do not contain each of these aspects should also be developed to improve the quality of new projects.
- ITP should consider life-cycle benefits when evaluating new proposals and should conduct literature searches to make sure that research is not a repeated or redundant effort previously attempted.
- ITP should also consider providing deployment assistance for some of the successful, high impact projects that need help with commercialization. While funding may be a part of deployment assistance, several other methods such as technology conferences should also be considered to supplement or replace funding efforts.

Project Recommendations

The 24 projects that participated in the Forest Products Peer Review can be sorted into three groups:

1. On-going: projects that have funding continuing into the 2007 fiscal year
2. Near commercialization: projects ending in the 2006 fiscal year (FY06) that are near commercialization
3. Ending: projects ending in FY06

The ITP reviewers completed evaluations for these projects; however, discussions focused heavily on the on-going projects since these are the projects that will continue to receive ITP funding. The evaluations addressed a wide range of programmatic, technical, and commercialization issues. In addition to the written comments, summarized in the Project Review section of this report, the reviewers were asked for numerical responses to five key questions. The numerical questions and scores for each project can be found in Appendix B along with the written responses. Table 3 summarizes the results of the numerical responses by project category¹. The maximum possible overall numerical score for a project is 16. The eight on-going projects averaged an overall score of 10.25, with a range of 7.33 to 13.00. The seven projects near commercialization averaged an overall score of 11.16 with a range of 7.33 to 15.00. The on-going projects' overall numerical score for energy savings potential were the highest of the three categories, while the average innovation, project plan, commercialization, and project fit scores for the projects nearing commercialization were the highest of the three categories.

Taking a closer look at the numerical scores and written comments, three projects in the on-going category require further discussion:

1. *Improved Wood Properties Through Genetic Manipulation*: This project's overall score was low due to low energy savings potential, low commercialization potential, and project fit scores. This project does not fit into ITP's current forest products portfolio because it was funded under a different strategy. Based on the excellent quality of work noted by the reviewers and the fact that this project's funding is about 95% complete, the reviewers concluded that ITP should complete their funding obligations for this project.
2. *Development of Renewable Microbial Polyesters for Cost Effective and Energy-Efficient Wood-Plastic Composites*: This project's overall score is low because one of the reviewers gave lower scores for energy savings potential, innovation, commercialization potential, and project fit than the other two reviewers. These lower scores are influenced by the fact that this project does not directly address energy savings that can be claimed within the forest products industry but instead will impact fossil fuel use in plastics manufacturing. The reviewer indicated this technology would fit better within a program developing bio-based products.
3. *Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives*: This project's overall score is low due to a low energy savings potential and project fit. The reviewers commented that this project has high public benefits but does not fit the newer ITP portfolio strategy and needs to quantify the energy savings benefits to maintain ITP funding support.

¹ Table 2 in the Portfolio Characterization section identifies the projects in each category.

Table 3. Summary of Numerical Project Evaluations			
Overall Scores for all 5 Questions	Average	High Score	Low Score
On-going projects	10.25	13.00	7.33
Projects nearing commercialization	11.16	15.00	7.33
Projects ending	7.58	12.67	2.00
All Projects	9.51	15.00	2.00
Maximum Possible Score	16.00		
Scores for Question 1 (Energy Savings Potential)	Average	High Score	Low Score
On-going projects	2.54	3.33	1.00
Projects nearing commercialization	2.33	3.67	0.00
Projects ending	1.52	3.00	0.00
All Projects	2.10	3.67	0.00
Maximum Possible Score	4.00		
Scores for Question 2 (Innovation)	Average	High Score	Low Score
On-going projects	1.96	3.00	1.00
Projects nearing commercialization	2.04	3.00	1.33
Projects ending	1.58	2.67	0.67
All Projects	1.84	3.00	0.67
Maximum Possible Score	3.00		
Scores for Question 3 (Project Plan)	Average	High Score	Low Score
On-going projects	2.42	3.00	2.00
Projects nearing commercialization	2.59	3.00	1.67
Projects ending	2.25	3.00	0.67
All Projects	2.41	3.00	0.67
Maximum Possible Score	3.00		
Scores for Question 4 (Commercialization Potential)	Average	High Score	Low Score
On-going projects	1.67	3.00	0.67
Projects nearing commercialization	2.21	3.00	1.00
Projects ending	1.08	2.33	0.00
All Projects	1.61	3.00	0.00
Maximum Possible Score	3.00		
Scores for Question 5 (Project Fit into the Portfolio)	Average	High Score	Low Score
On-going projects	1.67	3.00	0.67
Projects nearing commercialization	1.96	3.00	0.00
Projects ending	1.21	2.67	0.00
All Projects	1.58	3.00	0.00
Maximum Possible Score	3.00		

The other two project categories contain projects with funding that will be completed in FY06. In these two categories, ITP should look more closely at energy savings and commercialization potential and determine its role in deployment of these technologies. Three technologies from the nearing commercialization category stand out with high energy savings and commercialization potential:

1. *Development and Full-Scale Demonstration of Multiport Dryer Technology:* The reviewers indicated that this is a good project for ITP funding because it is a retrofit technology that provides economical benefits to end-users. Also, the project has a key player involved in the evaluation and marketing of the technology, enabling the technology to penetrate the market if the high-pressure steam trials are successful.
2. *Lateral Corrugator: An Improved Method of Manufacturing Boxes:* The reviewer comments for this project are all positive; of particular note is the involvement with a number of end-users and

equipment suppliers. Commercialization depends on a successful demonstration of the technology.

3. *Development of Methane de-NO_x Reburning Process for Wastewood, Sludge, and Biomass Fired Stoker Boilers*: This technology is commercially available.

The reviewers did not specifically mention actions that ITP could take to aid these projects in their commercialization efforts but suggested that the Forest Products subprogram work with ITP's Technology Delivery program and industry organizations to help increase mill awareness of emerging technologies. Another project in the nearing commercialization group that stands out is: *Fibrous Fillers to Manufacture Ultra-High Ash/Performance Paper*. This project was evaluated as an innovative technology with potentially significant energy benefits. However, this project's weakness lies in the commercialization potential due to a lack of industry involvement and a risky licensing strategy. The technology is under mill trials; once these trials are complete, the results need to be disseminated across the industry.

The average numerical score for the projects in the ending category is the lowest of the three categories. Two projects stand out due to decent energy savings potential scores and positive reviewer comments:

1. *Rapid, Low Temperature Electron, X-Ray, and Gamma-Beam Curable Resins*: This project had good numerical scores for all criteria except for commercialization potential because there is not yet a clear commercialization path.
2. *Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites*: This project's weakness also lies in the commercialization path. The reviewers pointed out that there are still technical issues that need to be overcome and therefore, retrofitting an existing mill with this technology would be risky.

These two technologies, along with the nearing commercialization projects mentioned above, may benefit from activities to increase industry participation in commercialization.

Appendix

Appendix A: Strategy Questions and Reviewer Evaluations

Strategy Questions

S1. Strategy Alignment with ITP mission and objectives (Does the Forest Products (FP) subprogram strategy align with ITP's corporate strategy of pursuing R&D in areas with high technical risk and significant energy savings potential? Can the alignment between the FP strategy and ITP corporate strategy be improved? What changes to the strategic focus would you suggest be investigated?)

S2. Strategy Alignment with FP Industry vision and interests (Are there sufficient market drivers for adopting technologies developed with under the current strategy? Does the Forest Products Subprogram strategy support the industry's vision of the future (e.g. the Forest Biorefinery)? Can the Forest Products strategy better support the industry's vision and interests within the context of ITP's mission and objectives? If so, please describe.

S3. Identification and Prioritization of Focus Areas (Has the FP subprogram identified the correct focus areas for achieving significant energy savings? Has the FP subprogram properly prioritized its focus areas giving funding constraints? What changes in focus areas or pathways would you recommend? Please discuss any problems or issues that you see with the focus areas selected for this portfolio.)

S4. Technical Barriers and Goals (Has the FP subprogram identified the key technical barriers in each focus area? Is there sufficient technical risk in overcoming these barriers to justify government investment? Are the technical goals for each focus area clear and achievable? What changes to the technical barriers and goals would you recommend? Please discuss any problems or issues that you see with the technical barriers and goals of each focus area.)

Reviewer Strategy Evaluations

Question	Reviewer Comments
S1	<ul style="list-style-type: none">• Focus on projects with high technical risk is clearly an appropriate role for ITP and the FP area of emphasis• Alignment between FP strategy and ITP corporate strategy could be improved and should be improved. Emphasis on mature technology that does not offer breakthrough technology should be avoided.• ITP's mission is to reduce the energy intensity of manufacturing. I believe there may be better ways to address this mission than the FP subprogram strategy considering the current state of the U.S. paper industry if we want to "base our strategy on sound analysis and produce results".• The current project portfolio does not include projects that can reduce steam demand by 15%. There are practical things that can be done on paper machines that can achieve the 15% goal. I feel the "Best Practices" approach could be used to achieve results and expedited to make sure that the 15% reduction target well before 2015 and before more paper mills are shut down due to high energy costs. Is there peer review of the best practices program to make sure that suggestions are up to date and the most effective?• There may be some research projects required to improve practical technology to improve steam savings that should be added to the research portfolio. This could include projects such as how to tighten paper machine whitewater projects without adversely affecting paper quality, reducing water use in bleach plants, and interconnecting pulp and paper mill water systems to reduce water consumption and save steam.

	<ul style="list-style-type: none"> • Based on cost and current performance of black liquor gasifier projects, there is some doubt in my mind as to whether this is a cost-effective approach especially if steam generation is reduced. Comments included in the G-P, Big Island gasifier quarterly report indicated that there were significant issues to resolve. The Big Island project has cost well over \$100 million and the Big Island pulp mill is relatively small compared to other integrated pulp and paper mills. I do not know the details on the Weyerhaeuser-New Bern project but have heard that the economics are marginal depending on energy cost. Paper companies generally only consider capital projects that provide high rates of return and have short payback periods. There appears to be a lot of work to be done before gasifier projects fit this mode. • Economics of biorefineries need to be thoroughly evaluated before considering them a primary goal. I do not have a feel if comprehensive economic reviews are done on potential energy technologies. There appear to be a lack of economic evaluations on some of the projects we reviewed. • There are greater opportunities for use of alternate fuels even though some mills have been burning old tires, agricultural waste, etc., for many years. There may be research opportunities to help mills determine the best ways to use alternate fuels. • Perhaps a primary goal should be to encourage development of energy efficient technology that would lead U.S. pulp and paper industry to self-sufficiency on renewable fuels and power. The U.S. pulp and paper industry is a large user of fossil fuels and this area definitely needs to be addressed. • Two primary areas of technology development should be evaporative water removal on paper machines and black liquor evaporators. Moderate improvements in these areas could provide significant reductions in fossil fuel use. • Someone also suggested that there should be a major focus on finding an alternative to kraft pulping. That would be a humongous task and it is doubtful that the paper industry would support this goal in its current economic climate and relatively short-term focus. • For the most part the FP subprogram strategy aligns with ITP's corporate strategy. Justification of a biorefinery project as an energy project is a bit of a stretch in my mind. Sounds like a product driven project that may save some energy. • If life cycle analyses of energy changes (environmental issues also) are used, there is a reasonable possibility that large energy reductions can be associated with projects that have apparent public benefit. Examples from the currently reviewed projects include the two projects that relate to recycling paper – Mechatronic Design and Screenable Wax. Such projects have a political attraction to a broad group that may be the basis for advocating for more funding, while the identified energy savings meet department focus, even though the saving may be a step or two away (enabling) from the actual application of the technology. If one were to make a category for such projects, the requirements would be to associate the proposal with the public benefit (usually environmental improvement) and show very clearly the association with energy savings. This would give the opportunities for proposals to come in that are outside the narrow foci of the two areas identified; a broader spectrum of proposers could remain involved. • In all proposals, the claimed energy and environmental savings, both direct and life cycle, should be explained in clear English, particularly identifying the assumptions used. • The FP subprogram almost aligns with ITP's corporate strategy. Significant energy could be better defined. I believe what we really mean is 15% after best practices have been implemented. Such a facility would already be in the lowest 25% of its class. Then we save an additional 15% by deploying "emerging technology" which ITP sponsors. • Technical risk is not specifically defined and it means technical risk of those projects in the public/private benefit overlap. Technical risk means something that is NOT incremental. A synonym is breakthrough. Perhaps these concepts can be incorporated. • Another issues is the elimination of the focus on the wood products sector. This is technical, political and social issue. There seems to be a couple of alternatives. One is to be very selective on wood products issues. The two projects about gluing with low/no energy have extremely high energy savings and could be considered on their own merits.
--	--

	<p>The second is to “transfer” this area to the Forest Products Laboratory (USDA-Forest Service), whose budget has also been cut.</p> <ul style="list-style-type: none"> • The Portfolio Management strategy is a clear upgrade to previous processes, which will be accepted by all but the customary renegades. There is the possibility tht these processes can slow development. Therefore, there needs to be a mechanism to not slow the “winners.” Maybe something can be added to the Merit Review Process where say ~10% of the projects can move to the next stage by some sort of unanimous vote. • The alignment between the FP strategy and ITP corporate strategy can be improved with better definitions of significant energy and technical risk. • More money would also allow ITP to expand the focus areas. • The current ITP focus areas look very good, except for the omission of building products/wood products. I suggest including the very upper end of building products or transferring it to another department who is willing to publicly accept it. • Recycling is not there either but I am personally more comfortable with this outcome. Recycling can be part of the integrated biorefinery and that may be a good compromise. • In general, the FP strategy aligns well with the ITP corporate strategy of pursuing R&D in areas with high technical risk and significant energy savings. There is always a trade-off between high risk R&D and possibilities of commercial success. Given the extreme risk adverse nature of the FP industry, I think the current ITP-FP strategy is a good compromise. • I also like the current strategy of small duration, relatively small amounts of funding for projects given future budget scenarios. • Need a good story to sell the public benefits of the forest products subprogram and ITP as a whole to secure funding. • The forest products industry brings an established biomass collection system that corn farmers do not have; an advantage for ethanol production, which currently has political support. Other industries do not have the infrastructure for biomass collection. • Most of the projects we fund now are incremental and will continue to be, can’t do high risk research with the funding we have; however, stage-gate system will allow us to fund high risk projects. • Make sure and distinguish that the 15% steam savings is after best practices, does not include best practices, but is 15% savings from state-of-the-art mills. • Electricity isn’t something that people measure well, if you purchase less than someone else (utility, independent producer) is producing less, likely using natural gas so you actually save natural gas that didn’t get burned up in an electric generator some 100 miles away – ITP should get credit for this. Life cycle consideration should be taken into account for research. Reinforce that energy companies and mills will use savings to reduce their highest cost fuels.
S2	<ul style="list-style-type: none"> • Many of the projects have excellent economic drivers; however the current portfolio also has projects that are not capable of delivering economic benefit. • The forest biorefinery needs to be a key focus and linkages established to create the science for achievement of the economic benefits. Today funding does not create the optimum economic benefit. • The forest products strategy can better support industry’s vision and interests within the context of ITP’s mission and objectives. Gasification must receive sufficient science and capital focus to achieve commercial success. Biorefinery needs to have the science developed to achieve economic success. • The probability that significant developments will occur elevates the practicality of biorefineries. • There are sufficient market drivers for adopting technologies developed under the current strategy, but the money is lacking, even for very good ideas that carry significant risks of revenue losses and/or capital expenses. • I don’t know what the industry’s overall vision of the future is. Significant reduction in manufacturing costs through energy savings is certainly desirable.

	<ul style="list-style-type: none"> • Even in the very preliminary proposals – concept design and evaluation – the proposer should be able to explain how his/her proposal has a relation to the interests of the industry. From the currently reviewed projects, the one about HAPs and VOCs from drying kilns would have a very difficult time explaining why industry should be interested. • The market drivers for adopting technologies developed under the current strategy are almost sufficient. The issue is that natural gas represents the highest energy cost and saving 15% steam does not exactly match. However, the lime kiln (included in the goal) is typically a large natural gas user in most kraft mills. Another high use of natural gas is hoods for Yankee and TAD tissue machines. Some mills do use natural gas to generate steam and here there is no issue. There is a question of focus verses inclusiveness. For focus one wants to say -15% steam. For inclusiveness one wants to reduce the use of natural gas. • The FP strategy supports the industry's vision of the future, except for the wood/building products area. The public knows housing costs are going up and some building products are in the public benefits sector. • The FP strategy can better support industry's vision and interests by including top end projects in wood and building products and natural gas reduction. • The current strategy of reducing steam demand and energy demand in general dos support the industry's vision of the forest biorefinery. However, there is internal dissent in the industry about going forward with the forest biorefinery concept. So therefore, I question whether serious progress on this front can be made until the industry truly becomes committed to this approach. • There was very little discussion about economic justification. Also, ITP needs to fund projects that address deployment. • Research without deployment is a waste; however, ITP should not necessarily reject proposals that do not address economics – scientists are not good at this, you will be wasting their valuable time. Partners should help them address economics; projects teamed with industrial partners tend to be more successful. • Need a literate discussion of why the project is a good thing, if you don't get this then mail the proposal back and ask them to try again. • Mills need help with EPA; there is resistance to energy changes due to potential EPA permitting – this takes 2 years. Need an environmental impact studies to sell to mills for technology adoption. EPA does not give credit for saving carbon dioxide. EPA and DOE should work together to save energy. The EPA regulatory process is the greatest retardant to energy efficiency. Add permitting questions to Stage 4 RFPs.
S3	<ul style="list-style-type: none"> • Yes, the FP subprogram has identified the correct focus areas for achieving significant energy savings. • At this time, the FP subprogram has not properly prioritized its focus areas given funding constraints. • The FP subprogram focus areas appear reasonable but the key will be finding projects that can provide quantum improvements in energy use technology. • I believe there should be an additional category in which a proposer would have to show large potential energy saving, other benefits to industry, and a large or well-recognized public benefit. • The FP subprogram has almost properly prioritized its focus areas given funding restraints. The focus areas include one high user of natural gas (lime kiln) but does not include wood/building products. • I think the current FP subprogram focus on decreasing steam utilization and natural gas usage are appropriately focused. • Given the current and persistent poor financial health of the FP industry, the industry is unlikely to make any drastic changes due to their high cost of capital. Hence only incremental, relatively low cost improvements are likely to be implemented. Incremental improvement, low cost type projects are appropriate.
S4	<ul style="list-style-type: none"> • The FP subprogram has identified the key technical barriers in each focus area to a great extent.

	<ul style="list-style-type: none"> • Drying heat transfer efficiency is a barrier using today's technology. Regarding the goal of steam use reduction, goal may be appropriate but needs to be communicated in a way that is easily understood by a non-technical audience. • I felt that long focus goals should have a reasonable probability of success. Some research will be required to improve the probability of reaching goals but some of the goals may be achievable only with unjustifiable capital spending. • The FP subprogram has identified the key technical barriers in each focus area • There is sufficient technical risk in overcoming the technical barriers to justify government investment, maybe too much risk. • The technical goals for each focus area will be difficult to achieve, this field has been well plowed. • Again there seems to be some focus on major technology advancements that will not be easily implemented, e.g. alternative to kraft pulping, autocauticization (did autocauticization fail in Australia? Is there some new technology?) • The fibrous filler project should be moved to the Advanced Dewatering focus area • What may be missing is how to include secondary fiber operations into the integrated biorefinery concept. • The energy intensiveness of wood gluing and curing should be added to the wood products barriers, as this is the high-end energy use. • My experience and expertise tells me that there is sufficient technical risk. This should be documented in the FP strategy. I think this is doable with a few compelling sentences. For example, in pressing we can say that the industry has moved from ~1 inch "nips" at 500 pli to 2-3 inch nips with large rolls at 1500 pli to 4-6 inch nips with "shoe presses" at 6,000 pli. This has moved press solids from 30/35% to 45/50%. Extending this technology to get 70% solids would require loads of at least 24,000 psi, which is not mechanically feasible. Clearly, we are near the technical limit of squeezing and a breakthrough technology is needed. There is no commercial organization that can support this kind of high-risk research. • The technical goals for each focus area are clear and achievable, but we have not provided that information. For example, we can state that pressing 70% solids has been achieved on bench scale equipment where the commercial mid nip solids can be preserved with stationary technologies. • I would add a few compelling sentences to the technical barriers and goals to explain why each is high risk and why we believe each is achievable. • Some of the portfolio accomplishments are not widely used and several highly rated projects need serious deployment assistance (Fibrous Fillers, Green Liquor Pretreatment, and both of the low energy glue projects). Consider working on the deployment effort of these technologies. • I see no problem with the FP subprogram technical barriers. Given the ultra extreme risk adverse nature of the FP industry, pursuing relatively low risk technologies and approaches is appropriate. A high-risk, high cost approach is not appropriately matched with the FP industry. • Need to mention that permitting process is a technical barrier to commercialization/industry adoption.
Additional Comments	
	<ul style="list-style-type: none"> • Rank energy savings by type of fuel saved to the extent it can be known; a BTU from one source is not a BTU from another source. The following are ranks I would propose: <ol style="list-style-type: none"> 1. Direct savings of natural gas and petroleum products. 2. Direct savings of purchased electricity as electric generation in the U.S. is primarily natural gas driven at the margin. When evaluating electricity saved, recognize that a BTU of electricity (1 kWh = 3413 BTU) saved is probably equivalent to two BTUs of natural gas as the efficiency of modern combined cycle plants is still slightly over 50%; if the gas generator exhausts to atmosphere without heat recovery and further steam driven electricity generation, the efficiency of gas fired generation is far less and the fuel

	<p>savings far more.</p> <ol style="list-style-type: none"> 3. Indirect or life cycle savings of natural gas, petroleum, or electricity. 4. Direct and indirect coal savings. 5. Savings of renewable fuel or energy, such as wood waste, black liquor, or wind. <ul style="list-style-type: none"> • In terms of ranking projects, ITP may wish to consider weighting factors assigned to different types of fuel or energy. • While the industry goals stated are sound, if capital is required (it usually is) to implement a concept or projects, there should be an adequate financial return on investment. Reducing costs or increasing markets and sales are not attractive to industry if the capital costs to implement is too high. For all but demonstration project proposals, the measure should be simple pretax return on investment or the inverse, payout time. Complicated financial analysis should not be necessary. Industry partners should be able to provide perspective on the economics. • Reducing steam demand is a goal that relates to enabling black liquor gasification because the mill energy balance changes. If a pulp and paper mill were to implement biomass gasification, the amount of biomass gasification is limited by two factors – the amount of biomass available and the available steam sink. Thus reducing steam demand may further limit the capacity of a biomass gasifier that can be installed unless one also installs more steam sink, such as a condensing turbine. • A primary forte of the forest products industry is gathering biomass in several forms from over a wide area and bringing it to a central point. It should be a key focus in setting goals. The identified difference between enabling black liquor gasification and restricting biomass gasification by reducing steam demand makes the goal of reducing steam demand less important than reducing fossil fuel demand at the mill. • Black liquor gasification produces more electricity or other products and less steam; the amount of possible black liquor gasification is directly related to the amount of black liquor at the mill, as it usually will not be brought from other locations. Biomass gasification is not limited by the amount of wood brought to the mill to make pulp. More biomass can be acquired purely for gasification purposes. • Some thought should be given to energy use on a life cycle basis. Here the industrial partner should have input to the proposals. • The FP strategy conveys that there are only minor direct savings possible in improved fiber recycling. Whatever significant energy savings there are fall in the indirect or life cycle category. • Recognizing that the categories of low energy water removal and high efficiency pulping are very important, I suggest at third category called “Other” in which good ideas that are not in the two identified areas but adequately address the drivers that led to those areas could be placed. • Perhaps an emphasis on more generally reducing energy intensity, rather than steam demand, with specific categories and the “Other” category should be considered. • I suggest that DOE facilitate a meeting with industry to display the portfolio of projects that reduce VOCs. In the past, the wood products side of the industry held a meeting annually to discuss developments in regulation of VOCs, particularly at wood products manufacturing locations. The audience at such a meeting should consist of environmental and technical people. To reach senior management, a communications package would need to be put together and send to CEOs over Secretary Bodman’s signature. • Additional benefits of the “Other” category are that a pathway for different good concepts remains available, there is an opportunity to remain connected to researchers not focused on the selected pulp and paper areas, and many of the “Other” areas will have “publicly recognized” public benefits. Enhanced recycling and reduced environmental emissions are more publicly recognized as public benefits than elimination of a lime kiln or decreasing the water content of the fiber mass going to the paper machine dryers. So long as the “Other” category projects meet the reduction of energy intensity goal and that is clearly explained in the energy, environmental, and economic terms, they should be considered. I also suggest that such projects are more politically attractive
--	---

	<ul style="list-style-type: none"> • Goals tie in with Agenda 2020 Roadmap & Energetics footprint • Important to use gasification in a general sense rather than just focusing on black liquor gasification, the benefits can be greater for biomass gasification • Focusing only on Advanced Water Removal and High Efficiency Pulping cuts out two significant portions of the Forest Products Industry: Paper Recycling and Wood Products - this could be politically dangerous • Recycling kraft paper (e.g. office paper) requires more energy than using virgin fiber (kraft pulping), however recycling groundwood (e.g. newspaper) requires less energy than using virgin fiber (mechanical pulping). • DOE's role should be to fund energy projects, not projects that would increase energy use, despite the other benefits. • Stage-gating is a good practice that is accepted by industry; however, it could cause logistic problems that hold up the research, such as getting funding to projects when research staff (particularly from universities) is available • Energy/steam savings could have more political relevance and connection with the Industry if the calculations were equated into natural gas/oil savings displaced by reducing steam demand. Problem is that if we say displacing barrels of oil, DOE management will say that you don't use much oil so how could you be replacing it. Perhaps mention in terms of ethanol, reducing steam demand by 15% will enable the forest products industry to produce and additional XX gallons of ethanol. • Mills need to be educated on the long term future of the industry. Mills (power house superintendent level) will say we have an imbalance already, they are buying more power and have excess steam. Money could be the issue, not just education on the long term future. • Combine R&D with Best Practices. Get current mills costs down using best practices and then sell new technologies to the mill, once you have their buy in or belief. Mills are currently technically thin. Use best practices to get them to focus on saving energy. Energy prices have not been high enough until lately to get mills focused on energy efficiency.
--	---

Appendix B: Project Questions and Reviewer Evaluations

Project Questions

P1. Energy Savings and Other Benefits (Does the project have significant energy savings potential? Are the energy savings assumptions provided by the PI conservative or overly optimistic? Is this technology broadly applicable across industry or will it only impact a few plants? Is the project likely to produce technologies that are easily implemented by the forest products industry within a practical timeframe? Are their significant environmental benefits of the technology beyond the benefits of emission reduction from reduced energy use?)

P1 Scoring. What is the technology's 2020 energy savings potential?

Scale (Anchor Point and Anchor Point Description):

0. The Project has an energy-savings potential(or enables technologies with energy savings potential) less than 1 trillion BTU per year (TBTU/year).
1. The Project has an energy-savings potential (or enables technologies with energy savings potential) greater than or equal to 1 TBTU/year.
2. The Project has an energy-savings potential (or enables technologies with energy savings potential) greater than or equal to 3 TBTU/year.
3. The Project has an energy-savings potential (or enables technologies with energy savings potential) greater than or equal to 5 TBTU/year.
4. The Project has an energy-savings potential (or enables technologies with energy savings potential) greater than 10 TBTU/year.

P2. Innovation and Technical Risk (How innovative is this project/product to the industry? Will the technology enable new the development of processes or products? To what degree are the scientific principles and/or technologies necessary for this project already understood, developed, applied and/or proven? Is the technical risk sufficient to justify government investment?)

P2 Scoring. How innovative is this project/ product to the Forest Products Industry? To what extent does it change industry structure?

Scale (Anchor Point and Anchor Point Description):

0. None. No innovation.
1. Incremental. Improves existing product or process. Typically a result of continuous improvement efforts or competitive activity.
2. Substantial. Changes basis of competition within the forest products industry, by altering market demand and dynamics or introducing new technology or process. Has a profound effect on the US-based industry.
3. Transformational. Creates new markets, businesses or fundamentally changes industry structure.

P3. Project Management (How effectively has the project team addressed technical hurdles, and overcome unforeseen obstacles? How well is the project team functioning as it relates to meeting its technical objectives as currently budgeted and scheduled? Is there a technical expertise that the team currently lacks that will be important for the success of the project? Identify technical hurdles not addressed by the project, and suggest improved methods to address both identified and unforeseen obstacles. Are there weaknesses in the team's project plan? If so, how can the plan be improved?)

P3 Scoring. To what degree is the project plan (budget, milestones, timing, etc.) appropriate to delivering the project objectives?

Scale (Anchor Point and Anchor Point Description):

0. The project plan (budget, milestones, timing, etc.) is not realistic for delivering the project objectives.
1. The project plan is marginal for delivering the objectives.
2. The project plan is fair for delivering the objectives.
3. The project plan is a good one for delivering the objectives.

P4. Commercialization Potential (Does this project address a need identified by the end users? Are potential end-users committed to this project? Will they be involved in the demonstration phase as now envisioned? Will the economics of the technology encourage industry adoption? Does the project lead have a financial incentive to commercialize the technology across industry? To what extent are there other technologies being developed that will compete (commercially) with the technology being developed or are their existing patents (or patent applications) that might interfere with the right to practice the technology? Are there external risk factors that could prevent the technology being commercialized? To what extent does the project team (including the commercialization partner) have the commercial expertise (sales, marketing, etc.) and experience in the required markets to meet the commercial objectives of the project? What is the likelihood that the project will yield a commercial success?)

P4 Scoring. What is the likelihood that the project will yield a commercial success? Estimate the overall probability of commercial success.

Scale (Anchor Point and Anchor Point Description):

0. Overall probability of commercial success is <30%. If all technical objectives are met, commercial success is not likely. The business climate and/or forecasts make it unlikely that this project will be able to attract a timely commitment from key end users. This project has serious problems in both concept and execution.
1. Overall probability of commercial success is <50%. Commercial success is in jeopardy. Technical feasibility is questionable. Business conditions or forecasts do not appear realistic. Major revisions to the project scope and/or commercialization plan are needed if success is to be achieved.
2. Overall probability of commercial success is >50%. Commercial success appears likely. Technical feasibility is reasonable, but revisions to the project scope and/or schedule are needed to keep the commercialization plan realistic.

- Overall probability of commercial success is >80%. Commercial success is probable. Technical feasibility is good. Business conditions are favorable for widespread implementation.

P5. Project Fit into Portfolio (Does the project address a key technical barrier? Does the project fit into program's portfolio strategy? Does the project support ITP's mission of reducing the energy intensity of manufacturing processes? Is the project redundant with other projects in the portfolio?)

P5 Scoring. Does the project fit into ITP's Forest Products Portfolio strategy of reducing steam demand?

Scale (Anchor Point and Anchor Point Description):

- No, the proposed technology addresses does not fit into the steam reduction strategy and does not fit into ITP's larger mission of reducing the energy intensity of manufacturing processes.
- No, the proposed technology addresses does not fit into the steam reduction strategy but does fit into ITP's larger mission of reducing the energy intensity of manufacturing processes.
- Yes, the proposed technology addresses does fits into the steam reduction strategy but does not address one of the pathways identified in the priority focus areas.
- Yes, the proposed technology addresses does fits into the steam reduction strategy and addresses one of the pathways identified in the priority focus areas.

Panel 1 Reviewer Project Evaluations

Project: Highly Efficient D-GLU Pulping		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> Projected pulp yield increase is 2-3%. Lime kiln energy use is projected to decrease by 35% and digester energy use by 30%. Emission reductions are anticipated by reduction in a bleaching stage. 	<ul style="list-style-type: none"> Projected lime kiln energy reduction is 10-35%. 	<ul style="list-style-type: none"> Yes, the project has significant benefits and the author's estimate of 10-30% at the limekiln is realistic. It could, in theory, virtually impact all kraft mills in the country. Primary limitations are: dead load to recovery and/or scaling in the digester. Unlikely to have spin-off technologies. Do not foresee any environmental benefits.
P2. Innovation and Technical Risk		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> NO_x emission increases, digester scaling, and evaporator fouling are all cited risks. Process configuration and flows are not defined at this point. Mechanism for thiourea catalysis is undefined as is the most viable method for formation. 	<ul style="list-style-type: none"> This technology may exist in several other mills that have not publicized results. Was a literature search completed? Thiourea and thiocarbamide catalyst work needs to be included in the project. Thiourea catalysis needs definition. 	<ul style="list-style-type: none"> This is not a particularly innovative project. Not likely to enable new processes. A literature survey should have turned up references to the basic concept. While not risky in the FP sense, the fact that this technology has not been implemented in the U.S.

<ul style="list-style-type: none"> This level of complexity and risk warrants government investment. 		<p>indicates that ITP-FP's money may have been well spent. Many projects could be like this one, i.e., the basic ideas/concepts may have been developed but the technology was not implemented due to economic factors and/or unfavorable enabling technologies. This may be an approach to use in ITP-FP's RFPs, i.e., ask for projects that saves energy through technologies with known basic constructs that have become attractive due to new circumstances.</p>
P3. Project Management		
Numerical Score: 2, 2, 3		
<ul style="list-style-type: none"> Appears that trials are progressing but organization is not clear. 	<ul style="list-style-type: none"> Good project management. Several mill management changes complicated project support and implementation. Appears that project could have been done more economically. 	<ul style="list-style-type: none"> Team seems to have overcome several setbacks beyond their control and now has a reasonable plan to proceed. PI is in contact with Andritz (digester supplier) who will have a vested interest in promoting the technology once proven. Andritz has been involved in the project at Samoa for over two years. The mill has been slow at returning calls recently. Andritz's internal lab data does not show a pulp quality benefit.
P4. Commercialization Potential		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> Economics would appear to drive commercialization, however, plans are not clear. Thiocarbamide or thiourea formation in green liquor process flows not well addressed. Project management and specific accomplishments need to be defined and responsibility clarified. Commercialization expertise is not clear. 	<ul style="list-style-type: none"> Benefits will be mill specific. Only applies to mills that are not recovery limited. Stage gate plan needed for commercialization. 	<ul style="list-style-type: none"> It is not clear how this technology will be implemented across the industry. Project Team should be encouraged to publish results (even negative results) quickly. Andritz and Metso providers of digester technology have a vested interest, but there is little money to be made by their promoting the technology. If the results are positive, the technology will be adapted quickly by the industry.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> This project has substantial energy savings potential and fits the portfolio. 	<ul style="list-style-type: none"> Good fit. 	<ul style="list-style-type: none"> This is an example of one type of projects that should receive priority from ITP-FP. It is based on an understood technology, can be implemented fairly easily, and is not expensive for the user or ITP-FP.

Project: Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft Cooks with Microwave Pretreatment		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 3, 4		
<ul style="list-style-type: none"> Reduction in H-factor by 40% is clearly a significant decrease in energy demand as well as the lime kiln natural gas savings projection at 40%. The assumption that the radio frequency (RF) applicator will produce the desired effect at the lowest energy level of 5 MW for all wood chip conditions appears optimistic. A more conservative assumption may be in order. Possible yield increase due to less demanding chip size. 	<ul style="list-style-type: none"> Benefits overly optimistic. Benefits will be mill specific. Could improve wood yield in mills with chip quality issues. 	<ul style="list-style-type: none"> Technology has significant energy saving potential. Assumptions are optimistic because they are based on all mills having an evaporator bottleneck. However, if chemicals are reduced even by 20%, as compared to PI's 40%, the direct energy savings at the lime kiln are huge. Could affect most plants. Do not see downstream environmental benefits of the technology.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> This is a breakthrough innovation for the industry. This is an additional process step. 	<ul style="list-style-type: none"> Hemicellulose stripping not proven, but will add benefits, if feasible. Not part of original project. May require metal removal to avoid microwave damage. 	<ul style="list-style-type: none"> Microwave treatment was explored at the University of Washington in the 70's. This does not mean that ITP-FP should have denied support, but all need to take advantage of the literature. Do not see spin-off technologies. This project fits the category of "risky enough."
P3. Project Management		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> Project execution appears very slow. Expertise appears present. Time to scale-up? 	<ul style="list-style-type: none"> Project has been around for several years. Appears to be some indecision on next steps. 	<ul style="list-style-type: none"> PI introduced a new technology (hemicellulose deposition) that is irrelevant with the proposed technology. A new project should have been applied for.
P4. Commercialization Potential		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> No comment. 	<ul style="list-style-type: none"> Need a microwave partner that understands the paper industry and can provide good marketing. 	<ul style="list-style-type: none"> This technology is very expensive to prove at a commercial-scale without proven benefits. Proven benefits are difficult to demonstrate at the full-scale level (a "chicken-and-egg" problem). Must prove that all chips are treated more or less equally all the time. If not, the results will be a disaster. Best approach was suggested by the PI, i.e., mill-scale trials treating only oversized chips. This reduces scale of trials by nearly two orders of magnitude. Commercialization plan addresses the chip fraction most likely to be impacted by the technology. Have substantial impacts on the operation of the wood yard and chip

		screening, e.g., chippers reset to produce more oversized and fewer chips fines. Less chips fines means more wood to the digester.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> No comment. 	<ul style="list-style-type: none"> Good fit. 	<ul style="list-style-type: none"> If successful, will save some steam; biggest energy savings will be natural gas at the lime kiln. If decrease chips fines to power boiler, will have to make up some other fuel if steam savings are insufficient.

Project: Hemicellulose Extraction and Its Integration		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Chemical savings. Energy savings. 	<ul style="list-style-type: none"> Excellent potential to reduce energy and chemical savings. Biorefinery concept adds value. Different numbers shown for potential yield increase. Removing hemicellulose by 25% will reduce recovery boiler load and permit capacity increases in many mills. Removing new product objectives from scope may reduce potential economics. 	<ul style="list-style-type: none"> An enabling technology for the future biorefinery. If successful, distant future energy savings may be substantial. Technology will impact only a few plants, if any. Will not produce technologies that are easily implemented. Do not know of any downstream environmental benefits.
P2. Innovation and Technical Risk		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Numerous risks and barriers exist, none of which are well enough understood to allow viable process without research and demonstration. These processes will be innovative. What percentage of lignin remains in the hemicellulose extraction? What are planned for its recovery and conversion to energy or chemical byproducts? Proposal numbers indicate a potential 3% yield increase. However, PI questionnaire results discuss 2%. What is the apparent cause and will it be resolved? 	<ul style="list-style-type: none"> Research needed to fully explore risks and demonstrate potential. Must find economic method to concentrate hemicellulose. Papermaking characteristics not considered. 	<ul style="list-style-type: none"> Technical risks are out of sight, but if successful, could transform the industry. Project is not innovative. Extraction and redeposition of hemicellulose is well known. Should have literature survey.
P3. Project Management		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> The elimination of Dr. Bozell's contribution detracts from the "new products", "new revenue" potential of this project – is there a plan to 	<ul style="list-style-type: none"> Appears to be well run. Conversion to polyester resins should be considered. PI does not seem very open to suggestions. 	<ul style="list-style-type: none"> No comment.

<p>overcome this situation?</p> <ul style="list-style-type: none"> What are the plans to bring in someone to partner in the polymer creation portion of the project? 		
P4. Commercialization Potential		
Numerical Score: 2, 2, 1		
<ul style="list-style-type: none"> The project has the commitment of a pulp end user and it is clear the pulp yield could be commercialized. It is not clear how biopolymers would be commercialized nor does there appear to be a partner with the proper competencies. 	<ul style="list-style-type: none"> ITP commercial partner likely has interest in increasing capacity in recovery limited mills. Yield increase will attract paper companies. Commercialization of biopolymers not clear. 	<ul style="list-style-type: none"> Very difficult to commercialize; currently there is no market for the extracted but undeposited hemicelluloses. As envisioned, the hemicelluloses will be obtained at very low concentrations. Very unlikely that evaporation is feasible. Others have failed in attempts to concentrate weak hemicellulose solutions via evaporation. This will make it difficult to recover the hemicellulose fraction that is not adsorbed. Complete success requires the successful development of a numerous products, markets, etc. Commercialization is limited by the huge amount of hemicellulose already available. With ITP-FP funding, the chances of success are much improved.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 0		
<ul style="list-style-type: none"> This project has the potential to have a dramatic impact on energy intensity within the industry as well as create "new products." 	<ul style="list-style-type: none"> Has good potential to reduce energy and create new products. 	<ul style="list-style-type: none"> This project is not driven by steam demand. Fits with FP strategy to the extent that it enables the biorefinery.

Project: Improved Wood Properties Through Genetic Manipulation: Engineering of Syringyl Lignin in Softwood Species Through Xylem-Specific Expression of Hardwood Syringyl Monolignol Pathway Genes		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> Replacement of softwood (Spruce) lignin guaiacyl structures with syringyl structures will reduce energy and chemical demand significantly in both digestion and bleaching. Application to a broad spectrum of pine as well as spruce softwood will impact many plants but timeline is several generations. 	<ul style="list-style-type: none"> Will reduce lignin content and result in softwood delignification rate and bleaching more like hardwood. 	<ul style="list-style-type: none"> No comment.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> The team has the knowledge and resources to provide a pathway that will regulate the 	<ul style="list-style-type: none"> Will take a long time for results to be demonstrated. 	<ul style="list-style-type: none"> No comment.

<p>formation of syringyl lignin. Negative side effects for the following will need to be addressed: hemicellulose biosynthesis, tree growth, and social acceptance of genetically altered tree species.</p> <ul style="list-style-type: none"> • Innovation is significant 	<ul style="list-style-type: none"> • Regulations may restrict application potential. 	
P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> • No apparent issues. 	<ul style="list-style-type: none"> • Excellent results and presentation; very professional. 	<ul style="list-style-type: none"> • No comment.
P4. Commercialization Potential		
Numerical Score: 2, 1, 0		
<ul style="list-style-type: none"> • Industry support appears strong, however, the new players (REIT structures) need to be involved. Economics will encourage adoption. Competition is from cloned forests in the southern hemisphere and related operations that are lowering the cost of pulp below that achievable in U.S. • Have the Fletcher Challenge Genesis Research and Development Patents on lignin modification been reviewed? 	<ul style="list-style-type: none"> • Need to develop process and plan for commercialization. 	<ul style="list-style-type: none"> • No comment.
P5. Project Fit into Portfolio		
Numerical Score: 0, 1, 0		
<ul style="list-style-type: none"> • Key technical barriers to existing process efficiencies are being addressed. • It fits the mission but exhibits some redundancy. 	<ul style="list-style-type: none"> • Should this be a Department of Agriculture (DOA) project? May be difficult to find sponsors if DOA project. 	<ul style="list-style-type: none"> • This project should not be funded by ITP-FP. This project should receive very large funding support somewhere else in the government rather than from ITP-FP. It has the potential of helping the U.S. catch up with offshore companies that have competitive advantages in wood cost and quality.

Project: Steam Cycle Washer for Unbleached Pulp		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> • This project has the potential to save substantial amounts of energy. • The PI may have optimistic savings, projections related to evaporator load; dewatering solids achievement is a must for these savings. • Reduced water usage will result if the claims are achieved. • What spectrum of pulps was 	<ul style="list-style-type: none"> • Good potential to reduce energy and water consumption. • Comparisons made to drum washers rather than state-of-the-art wash presses 	<ul style="list-style-type: none"> • Energy savings are very optimistic, partially due to use of an incorrect basis for comparison. Wash presses are commercially available and operate at 1.5 or so dilution factor. • Port Townsend is an older mill and probably not a good basis for comparison for general application. • Likely will have limited application: to old, small, batch digester mills. If successful at Port Townsend may

evaluated to document the dewatering solids achievement and pulp properties?		<p>find a few applications.</p> <ul style="list-style-type: none"> Altered pulp properties will be limiting. Environmental benefits limited except for mills such as Port Townsend.
P2. Innovation and Technical Risk		
Numerical Score: 2, 1, 1		
<ul style="list-style-type: none"> This is a totally new process for the industry. The technical risk is high and would not likely be attempted without Government funding. Achievement of the 28% consistency in real-time at commercial production rates is key to success. The device complexity must be proven over time in a production operation as sustainable at high process efficiencies. Suitability of the pulp quality for all grades is not clear from the presentation. What paper grades may not be able to tolerate the properties of steam cycle washed pulp? Scope may be limited. 	<ul style="list-style-type: none"> Appears to be complicated equipment that may be difficult to maintain in a mill environment. May have adverse affect on pulp quality for some grades. 	<ul style="list-style-type: none"> The washer design is certainly innovative, but its use is to replace existing washer/press designs, which are provide comparable performance and are widely deployed.
P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Project management appears to be satisfactory at this point. The CRADA needs to be put in place. Timeline may be optimistic. Proof of viability will require more than two quarters and it will not achieve commercial acceptance until well proven. 	<ul style="list-style-type: none"> Project management appears good. Project manager has experience with other similar equipment. 	<ul style="list-style-type: none"> Management of the project is excellent
P4. Commercialization Potential		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> If the commercial demonstration is successful economic drivers will drive market penetration. 	<ul style="list-style-type: none"> Commercialization may not be as large as projected when alternative proven equipment is considered. 	<ul style="list-style-type: none"> Port Townsend is underway and time will tell if it is a commercial technology. There are a large number of successful commercial alternatives. It will take at least a year or two to workout the bugs at PT. The design is mechanically very complex. Complexity as well as altered pulp characteristics, will be a limiting factor.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Project fits the portfolio well and addresses key energy 	<ul style="list-style-type: none"> Addresses energy reduction and water savings. 	<ul style="list-style-type: none"> It is the definition of one of the pathways. FP has placed a really

reduction and water resource conservation. • This project is not redundant.		big bet.
--	--	----------

Project: Laser Ultrasonics Web Stiffness Sensor		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> • Energy savings are expected. • Successful on-line control will increase machine salability and efficiency as well as customer satisfaction. • Unit testing is subject to shipment of unknown quantities of off-specification products. • Fiber savings result from allowing operation within a narrow tolerance band. • Energy savings is not a prime objective. 	<ul style="list-style-type: none"> • Some savings from reducing the percentage of first quality paper. • Applications will be machine specific. • Other paper specifications besides stiffness will limit results on some grades. • May provide smoothness measurement. 	<ul style="list-style-type: none"> • This is not an energy driven project. Savings calculations are not convincing. • Technology has broad implications if successful on printing papers and linerboard. • Unaware of any environmental benefits.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 1		
<ul style="list-style-type: none"> • The involved paper physics, laser-ultrasonic method, and mathematical conversion of information allowing non-contact measurement, all represent a novel, breakthrough concept. The risk justifies government investment. 	<ul style="list-style-type: none"> • Non-contact sensor unique development. 	<ul style="list-style-type: none"> • Project concept is creative and innovative. However, as a practical matter, the results will be incremental.
P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> • Reported 1.5 years longer than anticipated, but compliant to budget. 	<ul style="list-style-type: none"> • Very long project. I first heard about this project in the mid-1990s. • Budget compliance good even though project took 1.5 years longer than expected. 	<ul style="list-style-type: none"> • Project seems well organized currently, if not so well in the past (schedule). • Results going forward will be determined by ABB.
P4. Commercialization Potential		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> • This project meets a well-defined need. Economics will drive adaptation. The team has the proper parties involved to commercialize. 	<ul style="list-style-type: none"> • Appears to be some interest. • Commercialization should be by ABB. • DOE funds should not be provided to assist with commercialization. 	<ul style="list-style-type: none"> • With a firm commitment from ABB, this project has a very good chance of commercialization if it functions well technically. • Industry will adopt fairly quickly as capital becomes available. • Not aware of any competing technologies. • Finding the industry partner to go to the next commercialization step could be difficult.
P5. Project Fit into Portfolio		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> • Project does not fit portfolio; redundancy is not apparent. 	<ul style="list-style-type: none"> • Does not appear to fit ITP-FP portfolio. 	<ul style="list-style-type: none"> • This is not an energy driven project. • Does not fit with ITP-FP strategy.

Project: Development and Full-Scale Demonstration of Multiport Dryer Technology		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 2, 3		
<ul style="list-style-type: none"> This project is focused on energy savings potential in the dominant Industry drying process and has potential to dramatically improve productivity over conventional dryer configuration with a 7-fold heat transfer rate increase. Heat transfer vs. spoiler bar equipped dryers is also improved by 20%. 	<ul style="list-style-type: none"> No energy savings were discussed in the presentation. Projected energy savings of 17 trillion Btu/yr by 2030 in the quarterly report are overstated. This technology should provide higher heat transfer rates to permit higher production rates and improved cross machine moisture profiles but energy savings will be minimal. Energy cost could go down slightly if operating with lower steam pressures permits operating from lower pressure steam headers. 	<ul style="list-style-type: none"> If this technology is successful operating at lower pressures, it could increase power generation in mills as well as back pressure turbines. Do not have a feel for the energy calculations. Technology could be attractive in a large number of mills, particularly older mills. If pilot testing proves positive, technology could be implemented in short timeframe. Do not see any environmental benefits.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 1		
<ul style="list-style-type: none"> No previous design models are available; this is breakthrough technology that requires an entirely new concept for dryer internals. Differential pressures in early prototype designs were not practical within the scope of current dryer condensate and steam control and management systems. Government investment is warranted. 	<ul style="list-style-type: none"> Unique concept for increasing heat transfer. Equipment is not proven in a pilot dryer. Some hardware limitations were noted in smoke tests and other problems may arise during high-pressure steam trials. If successful, multiport technology could be installed in new Yankee dryers. This would provide a significant reduction in cost of manufacturing a new Yankee dryer. Improved heat transfer in Yankee dryers could reduce consumption of natural gas for Yankee hoods and increase the overall drying rate. Multiport technology could increase heat transfer rates on de-rated dryers and dryers produced before 1940 that were not pressure coded. 	<ul style="list-style-type: none"> Clever technology utilization of known principles. Do not see any new processes or products. Excellent project for DOE investment.
P3. Project Management		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> Project appears well managed. 	<ul style="list-style-type: none"> Project team seems somewhat naïve about some of the factors involved in paper drying including economics. 	<ul style="list-style-type: none"> Well planned and executed project. Has a key player involved in the evaluation and marketing of the technology.
P4. Commercialization Potential		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> Productive economics will drive commercialization. Kadant Johnson has the 	<ul style="list-style-type: none"> Successful commercialization will require heavy involvement by an equipment supplier that is very knowledgeable in paper 	<ul style="list-style-type: none"> Kadant Johnson is a key player in the market and technology would sell if test proves feasible.

economic incentive to commercialize and they have the technical marketing and sales network to accomplish this.	drying applications.	<ul style="list-style-type: none"> Unaware of any competing technologies. Likely to be commercially successful.
P5. Project Fit into Portfolio		
Numerical Score: 3, 1, 3		
<ul style="list-style-type: none"> This project meets ITP-FP's mission and is not redundant. 	<ul style="list-style-type: none"> Good technology to be supported by DOE, but will not have a significant impact on steam reduction. 	<ul style="list-style-type: none"> Technology overcomes a key technical barrier in existing mills, particularly older mills. Another example of the type of project DOE should support (i.e. energy savings in older less efficient mills).

Project: Lateral Corrugator: An Improved Method of Manufacturing Corrugated Boxes		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 4, 3		
<ul style="list-style-type: none"> 15% improvement in corrugated materials crush strength creates several options: sell an enhanced product, reduce material consumption, and reduce related recycle and waste volumes. Reducing material consumption dramatically decreases energy use in the applied manufacturing process. 	<ul style="list-style-type: none"> Excellent economics-15% weight reduction, reduced trim waste, transportation savings, and better trim on paper machines. Poor trim on containerboard paper machines is an expensive problem. Good trim is 98% of production but many machines are under 96%. It takes as much papermaking energy to produce unused trim as it does for first quality paper. 	<ul style="list-style-type: none"> Energy savings are not shown in the most recent update. PI points out that reduced waste and more optimized transportation strategies will contribute the most to energy savings. The savings are potentially very large. Technology will have broad application. If successful with pilot plant, the technology will be implemented quickly. Reduced truck/rail mileage/weight will improve air quality.
P2. Innovation and Technical Risk		
Numerical Score: 2, 3, 3		
<ul style="list-style-type: none"> This is an innovative concept! Sheet generation and positioning concepts used in this effort are used in other industrial applications. The novelty relates to application in corrugating and creating a viable process. Productivity of current corrugators may not be achievable with this operation. 	<ul style="list-style-type: none"> Some issues with glue machines need to be resolved. Innovative approach to resolving some major containerboard issues. 	<ul style="list-style-type: none"> Project is very innovative and was initially very risky. Risk has been reduced by the team. This technology is transformational in the sense that once one company does it all, the others have to follow and also since basic box design could be changed Chance new markets/products will be developed; at least existing markets are protected. Good project for ITP-FP to take on even if it is not driven primarily by energy savings.
P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Project team appears to be functioning well and substantial collaboration exists with parties interested in the commercialization of the concept. Technical expertise is sufficient some 	<ul style="list-style-type: none"> Good project management. Assembled good team of suppliers and got them involved in development. PI has excellent knowledge of containerboard and good 	<ul style="list-style-type: none"> Project is very well managed. Seem to have identified and solved problems as they came up. PI is coordinating a large number of contributors.

<p>question on roles.</p> <ul style="list-style-type: none"> Is the IPST at GeorgiaTech the best organization to interface the sheeting, feeding, and splicing operation? Do the engineering and control skills exist? 	<p>industry contacts.</p>	
P4. Commercialization Potential		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> End users and equipment suppliers are involved in the project and contributions indicate demonstrated commitment. Economics and superior product will drive adaptation. Successful pilot operation will be required for commercialization. OIT has sponsored an alternate approach by an individual inventor—what acceptance has that met? 	<ul style="list-style-type: none"> Excellent potential. 16 paper companies closely following technology. One unit sold. 	<ul style="list-style-type: none"> Given the large number of team members both from the industry and its supporting vendors, one has to conclude, that the technology has large potential benefits and will be commercialized very quickly if successful. Not aware of any competing technologies, but if others are successful in producing a squarer sheet of linerboard, it could limit volume of the market for the corrugator. Seems to me that this technology is protective of the box industry. I am not aware of any external risk factors. Not sure that there is a plan for commercialization. PI has pulled together all of the necessary pieces from the supplier and industry side, but I do not think anyone is in charge of commercialization.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> Project fits a key technical barrier and fits the portfolio strategy; it is not redundant. 	<ul style="list-style-type: none"> Excellent and very practical fit in portfolio. Excellent use of DOE funds. 	<ul style="list-style-type: none"> Good fit with ITP-FP mission of saving energy, but does not save steam directly or address pathways.

Project: Improved Recovery Boiler Performance Through Control of Combustion, Sulfur, and Alkali Chemistry		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> Realistic, but does not represent any breakthrough contribution. Need new boiler to use information. 	<ul style="list-style-type: none"> Good technology, but not breakthrough. Most economic benefits will result from implementation on new boilers. Suggest getting Larry Baxter involved in improving black liquor gasification projects. 	<ul style="list-style-type: none"> Energy savings are modest, even according to the PI. Environmental impacts are also modest.
P2. Innovation and Technical Risk		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> Possible enhancement of old technology will be an outcome. Experimental work is 	<ul style="list-style-type: none"> Technology improvement on old boiler designs. Experimental work is innovative and adds 	<ul style="list-style-type: none"> I would characterize this project as basic science that might lead to improved recovery boiler performance.

innovative.	significantly to boiler knowledge.	<ul style="list-style-type: none"> • Very innovative execution of the project. • Risky project for ITP-FP to take on, but one of the right types of projects, i.e., an investigation to develop the science needs to improve one of the basic energy conversion processes of the industry.
P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> • Expertise appears to be present. 	<ul style="list-style-type: none"> • Project management appears excellent. • Unsuccessful in developing sulfur dioxide sensor. 	<ul style="list-style-type: none"> • A very impressive well-executed science project.
P4. Commercialization Potential		
Numerical Score: 1, 1, 2		
<ul style="list-style-type: none"> • Value impact appears small on recovery boilers; adaptation incentives weak! • Application to Black liquor gasifier. 	<ul style="list-style-type: none"> • Primary potential on new boiler designs. • Some concepts developed may apply to gasifiers. 	<ul style="list-style-type: none"> • Do not know what there is to commercialize, but the information developed may be very useful.
P5. Project Fit into Portfolio		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> • Impact is too low! 	<ul style="list-style-type: none"> • Good technology and knowledge improvement. 	<ul style="list-style-type: none"> • See Item 3 in Section P2 above. • Do not know where the project fits into the ITP-FP program, but he certainly should receive generous support.

Project: Performance and Value of CAD-Deficient Pine		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 1, 0, 0		
<ul style="list-style-type: none"> • Transportation and harvesting energy savings projected at 30%. 	<ul style="list-style-type: none"> • Faster growing trees produce higher wood yield. • Faster growing trees do not have an adverse affect on pulp characteristics. 	<ul style="list-style-type: none"> • This project should not be justified on an energy savings basis.
P2. Innovation and Technical Risk		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> • Lacks innovation. 	<ul style="list-style-type: none"> • Proven technology. • Ecology guidelines may restrict application. 	<ul style="list-style-type: none"> • No comment.
P3. Project Management		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> • No issues. 	<ul style="list-style-type: none"> • Thorough project plan and implementation. 	<ul style="list-style-type: none"> • No comment.
P4. Commercialization Potential		
Numerical Score: 2, 2, 0		
<ul style="list-style-type: none"> • No comment. 	<ul style="list-style-type: none"> • Already being done and will continue. 	<ul style="list-style-type: none"> • No comment.
P5. Project Fit into Portfolio		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> • This is questionable. 	<ul style="list-style-type: none"> • Should be a Department of Agriculture Project. 	<ul style="list-style-type: none"> • This is not an energy project.

Project: Development and Validation of Sterility Systems for Trees		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> Potential for implementation in a realistic time frame is poor. Energy conservation outcomes are speculative. 	<ul style="list-style-type: none"> Limited economic potential for paper industry. Would reduce wild growth of trees in managed forests. 	<ul style="list-style-type: none"> This project should not be justified on an energy savings basis.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> Innovation required and technical risks are significant. Social acceptance is questionable in the long run and therefore, the time and money expended will never bear positive results. 	<ul style="list-style-type: none"> Ecology limitations may be a barrier. Needs to be applied to other species. 	<ul style="list-style-type: none"> No comment.
P3. Project Management		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> No comment. 	<ul style="list-style-type: none"> Project appears to have been well managed. 	<ul style="list-style-type: none"> No comment.
P4. Commercialization Potential		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> Commercialization is questionable 	<ul style="list-style-type: none"> Commercialization not likely. Takes long time to change trees. 	<ul style="list-style-type: none"> No comment.
P5. Project Fit into Portfolio		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> This project does not fit. 	<ul style="list-style-type: none"> Should this be a Department of Agriculture project? 	<ul style="list-style-type: none"> This is not an energy project.

Project: On-Line Fluidics Controlled Headbox		
Reviewer #1	Reviewer #2	Reviewer #3
P1. Energy Savings and Other Benefits		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> Production of isotropic sheet eliminates many formation oriented defects: curl, misregistration inprinting, formation print mottle and a number of other conversion, and end use deficiencies. 	<ul style="list-style-type: none"> Improved CD strength will permit reducing basis weight and using less fiber on some grades. Application potential is limited. 	<ul style="list-style-type: none"> The word energy is not in the PI's notes for his presentation!!! May save some energy, if as is claimed, less fiber is dried to produce the same amount of product.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> Application of fluid dynamics, suspension hydrodynamics, paper physics, and instrumentation must be combined to succeed in this project. Creating axial vortex as the jet exits the headbox on a retrofit basis requires hardware software and instrumentation that does not exist. Need to discuss how your 	<ul style="list-style-type: none"> Innovative technology that was first developed 10+ years ago for tubes. Use with headbox sheets makes an easier retrofit on machines with existing sheets. Paper companies are hesitant to spend the capital required to retrofit existing headboxes. New tube design may not change with temperature as expected. 	<ul style="list-style-type: none"> Project is innovative and risky, but is not really justified on an energy savings basis.

plan controls suspension hydrodynamics.		
P3. Project Management		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> Progress appears satisfactory. The project should involve an organization that will commercialize the results now. 	<ul style="list-style-type: none"> Many different groups have supported development of this technology. Poor machine selection for first commercial installation. 	<ul style="list-style-type: none"> Seems to be well-managed and solving problems as they arise.
P4. Commercialization Potential		
Numerical Score: 2, 1, 1		
<ul style="list-style-type: none"> This appears to be a weak link in this program; a well thought commercialization plan does not appear to exist. Please detail your thoughts on commercialization. 	<ul style="list-style-type: none"> Limited application potential due to age and condition of many headboxes on U.S. machines. Expensive to install. 	<ul style="list-style-type: none"> May be a good technology but needs the support of a major paper machine supplier. All major paper machine suppliers are headquartered outside of the U.S. PI alone has no skills or interest to commercialize.
P5. Project Fit into Portfolio		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> Project does fit a key technical barrier and has potential to reduce energy intensity. 	<ul style="list-style-type: none"> No comment. 	<ul style="list-style-type: none"> Project is a theoretical fit for ITP-FP but is really not an energy driven project.

Panel 2 Reviewer Project Evaluations

Project: Development of Renewable Microbial Polyesters for Cost Effective and Energy-Efficient Wood-Plastic Composites		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 3, 1		
<ul style="list-style-type: none"> This project needs a life-cycle energy and environmental analysis. The process flow sheet presented in the talk helped, but the emphasis on an activated sludge source will add an extra step for mills that do not use the activated sludge process. I understand that activated sludge process is used at plants that are land constrained. A market with municipal sewage plants makes this more robust. This project also needs a good explanation of where the energy savings are made. Generally, the reader understands that the saving is the difference between the energy content of the plastic wood composites and the PHA composites, but calculations should be provided. 	<ul style="list-style-type: none"> The process is a little hard to understand and part of it was not well explained, maybe not known. Not all mills will adopt this, so the saving prediction needs to be tempered. 	<ul style="list-style-type: none"> The claimed energy savings are not direct to the FP industry; they are for displaced petroleum for plastics production. Not sure how realistic claim is that the HDPE could be replaced with PHAs from this process.

P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 1		
<ul style="list-style-type: none"> This project is innovative. Development of product prototypes will be critical. 	<ul style="list-style-type: none"> Very innovative and the second project (of 24) that could result in new products. However the technical risk is high and not yet proven. 	<ul style="list-style-type: none"> This project is innovative to the extent of using waste for a high value application. Not clear as to how this project hopes to address the significant cost barrier that exists to effective utilization of PHA production from this approach. The PHA property testing aspect of this project seems to be very good. Not clear as to the benefit of this project to FP industry.
P3. Project Management		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> To make this work, there must be a major role for the entity that will market the product. Strandex is identified, but I would like to have seen more of their involvement in the activity as presented in written and oral form. There seems to be a strong technical team. 	<ul style="list-style-type: none"> It is too early in the project to get a real handle on this but objectives are being met on the revised schedule. The PI seems overly optimistic and this could limit technical objectivity. 	<ul style="list-style-type: none"> Technical team assembled seems good with appropriate expertise. PI did a good job of modifying milestones to reflect changes in funding. Research on how to achieve cost objectives is not well identified.
P4. Commercialization Potential		
Numerical Score: 1, 1, 0		
<ul style="list-style-type: none"> The project is not far enough along to get a good perspective, but will need a significant input from Strandex. Given the source of the raw material, either pulp mill waste or sewage waste, the commercialization must be prepared to address any perceived risks with the source of material. 	<ul style="list-style-type: none"> If proof of concept and proof of product can be achieved, this will have big drivers for some mills. 	<ul style="list-style-type: none"> Very early stage project so commercialization potential is hard to gauge, but commercialization potential seems low. Bio-based polymers in general have been slow to achieve market acceptance and not clear as to commitment by Strandex to invest resources necessary to take to commercialization.
P5. Project Fit into Portfolio		
Numerical Score: 1, 2, 0		
<ul style="list-style-type: none"> To the extent that this project can displace the petroleum input to plastic lumber, it can make a real contribution and fit in the portfolio. It does not save steam. Again, that it could work with municipal sewage, it fits well in ITP's portfolio, if not ITP's forest products portfolio. One wonders if the current HDPE product can be made with recycled polyethylene. If so, the energy savings may be much less and the fit will be less. If the portfolio were to include an environmental component, this project would rank higher. 	<ul style="list-style-type: none"> If this project continues to pass the "go gates," it will deserve additional resources. 	<ul style="list-style-type: none"> Replacing petroleum-derived HDPE with PHAs from wastewater treatment systems is an admirable goal, but does not fit ITP-FP goal of steam reduction. Project seems a better fit with bio-based products type programs.

Project: Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> This project needs an energy analysis. While the AF&PA Task Force may assign 10 TBTUs annually, a better source may be Tom Friberg. Part of that analysis should be the savings by increasing the supply and quantity of recyclable paper. This analysis requires a life-cycle approach. 	<ul style="list-style-type: none"> PI was unable to answer this question – it needs an answer. An Agenda 2020 Committee said 10 trillion BTUs, but I will rate it lower until this is quantified. 	<ul style="list-style-type: none"> This project did a very poor job of addressing energy savings benefits, although they may be significant. The PI needs to take this aspect more seriously.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> This project is highly innovative. There are two distinct projects and I sense that the wax-corrugated application may have less risk, as far as recycling products used to ship vegetables. This side has very specific sources of recycled materials. Grocery stores, which have focused recycling systems, would likely find a non-waste outlet for the waxed corrugated. The PSA side seems more complex. 	<ul style="list-style-type: none"> The innovation may be as much commercial as technical in getting the adhesives industry to change when there are few drivers for them to do so. 	<ul style="list-style-type: none"> This project scores very well for innovativeness. The PI has a very well thought out and systematic method for addressing the knowledge needs for benign PSA utilization
P3. Project Management		
Numerical Score: 3, 1, 3		
<ul style="list-style-type: none"> This team appears capable. As long as the adhesive manufacturers stick with the effort, all should be well with the team. Since the wax corrugated recovered material goes to a specific type of mill, either corrugated medium or linerboard, it may be wise to add a paper mill to the industrial partnership. It would be unfortunate to complete the work and not have it develop because there were difficulties from a paper maker's perspective. 	<ul style="list-style-type: none"> They have an outstanding team but do not seem to have thought through or planned to use all of the potential drivers for commercialization. I hope they recorded and follow-up on all of the suggestions. The PIs need to be engaged in estimating (and achieving) energy reductions. This one was NOT. 	<ul style="list-style-type: none"> The PI comes across very well. His approach for addressing the critical issues for benign PSA utilization is good. The assembled team seems well suited for addressing the research and knowledge needs of this project.
P4. Commercialization Potential		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> There is no driving economic force to commercialize. Regulation seems to be the only possible driver beyond doing something good for the world. The executive order for the federal government to purchase green goods should 	<ul style="list-style-type: none"> They have an excellent track record on a previous project and if they follow-up on the suggestions, the commercialization potential seems high. 	<ul style="list-style-type: none"> In the classic sense of new technology commercialization, this project does not really require commercialization. Since the project took an appropriate approach to identify benign PSAs already in use and establish if correlations exist to desired PSA

<p>be the first step to getting the market side going.</p> <ul style="list-style-type: none"> The wax-corrugated side of the project should be commercialized first, as it is discrete and, although smaller in impact, is more focused. 		<p>properties plus other relevant data, this project should provide PSA manufacturers the information they need. However, no direct benefit to PSA manufacturers, hence motivation, may exist unless incentives or mandates are instated.</p>
P5. Project Fit into Portfolio		
Numerical Score: 1, 3, 0		
<ul style="list-style-type: none"> This project has high public and industry benefit. In this sense, it does not fit in the ITP new portfolio perspective. If the energy savings could be established, this answer would be very different. The presumed industry benefit is a larger, improved supply of recycled fiber. A life cycle energy analysis may show that there are significant energy savings. 	<ul style="list-style-type: none"> Energy benefits must be DOCUMENTED to deserve the high score given. 	<ul style="list-style-type: none"> This project has more public benefit than a private sector/individual company benefit, and therefore, is appropriate for DOE-ITP investment. However, to truly fit, energy benefits need to be quantified.

Project: HAPs Reduction from Drying and Pressing		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 3, 2		
<ul style="list-style-type: none"> This project has the potential to save a lot of gas as well as some wood and eliminate capital expenditures in the process of reducing emissions. The no capital cost with the knife angle technology and the low capital cost of the screening technology, are particularly attractive. If existing thermal oxidizers can be eliminated, the breadth of application will be even greater. 	<ul style="list-style-type: none"> The estimate was made 2-3 years ago in anticipation of a tough EPA rule. The rule was more relaxed and the estimate could be 50% higher. Also, it is unclear how many real-time operating systems (RTOs) will be replaced or avoided. Score discounted for these considerations. 	<ul style="list-style-type: none"> Typical for these types of projects, claimed energy/environmental benefits are natural gas savings compared to RTOs.
P2. Innovation and Technical Risk		
Numerical Score: 3, 1, 3		
<ul style="list-style-type: none"> This effort is an excellent combination of laboratory work and direct application in mills. The chemical polymer described by the researcher to control formaldehyde should also be attractive if it does not have separate adverse environmental effects. It should certainly be investigated in the next few months as the project nears completion. 	<ul style="list-style-type: none"> Very innovative and effective approach, but results are incremental. 	<ul style="list-style-type: none"> I would consider this project highly innovative in that it takes a very fundamental and systematic approach to identify the factors that lead to VOC/HAP formations and determine if process changes can be implemented to prevent/minimize VOC/HAP formation. Identifying fines as the issue, and determining a simple parameter (i.e., knife angle) that could be easily changed to minimize the formation of fines to result in reduced wood loss benefits, is a tremendous piece of work.

P3. Project Management		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> This project has a very complete team, involving three major wood products players. It seems well run and the industry representatives are quite pleased. The industry representatives also are involved, which is unusual and very desirable. 	<ul style="list-style-type: none"> The team needs to take responsibility for estimating energy impact. Could it be that they want to let the high number stand? DOE should demand a recount. Otherwise it is a strong team meeting deliverables. 	<ul style="list-style-type: none"> PI was extremely knowledgeable with a very good systematic research approach. Team was very good with clear involvement of industry.
P4. Commercialization Potential		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> The knife adjustment technology is commercialized and is a source of wood saving. The screening work is near commercialization and has executed trials effectively. The knife technology should spread through the industry rapidly with the screening progressing slower. If the polymer used to trap formaldehyde works and is not too expensive, it will commercialize rapidly. 	<ul style="list-style-type: none"> 2 out of 4 deliverables have already been commercialized. Likely that at least one more will be commercialized. However it appears that commercialization is confined to 3 immediate partners. DOE-ITP should insist that AF&PA make the entire industry aware of this technology. 	<ul style="list-style-type: none"> I cannot think of any logical reasons why these results would not be implemented with clear industry benefit. In fact, results are already being implemented. Of all these type of projects, this is clearly the best. This is an excellent example of a good project.
P5. Project Fit into Portfolio		
Numerical Score: 1, 2, 2		
<ul style="list-style-type: none"> This project reduces or saves gas and wood consumption, but not steam. It is a classic example of saving an end-of-pipe treatment step by making process improvements to eliminate the need for emission control. In many ways, this project was the most attractive in Panel 2. The comment made in discussion that this is a cross between best practices and sophisticated research is true. Has DOE-ITP developed a best practice module for wood products in which some of this work could be placed? 	<ul style="list-style-type: none"> There are several projects aimed at lowering VOCs and HAPs, however, I do not think the industry needs all of them. A process to sort and compare is recommended. 	<ul style="list-style-type: none"> This project is a good fit with the Forest Products portfolio in reducing natural gas consumption and has near-term potential.

Project: Biological Air Emissions Control for an Energy Efficient Forest Products Industry of the Future		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 3, 2		
<ul style="list-style-type: none"> This technology has application in several industries. It has the potential to displace thermal oxidation in the forest products industry, particularly in wood products. The life-cycle energy and environmental benefits are 	<ul style="list-style-type: none"> It is unclear how many real-time operating systems (RTOs) will be replaced or avoided. The Pls must take responsibility for correctly estimating energy savings. 	<ul style="list-style-type: none"> As is typical for these types of projects claimed, energy/environmental benefits are natural gas savings compared to RTOs.

large if this technology can be substituted for thermal oxidation. If mills with thermal oxidizers can use this technology instead, the energy savings would be even more attractive; this is a significant EPA question relating to possible backsliding while still meeting regulations.		
P2. Innovation and Technical Risk		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> The project is innovative, but has proceeded to a development state in which most of the risks have been understood and many barriers overcome. 	<ul style="list-style-type: none"> This is a new, but incremental process to the pulp and paper industry. 	<ul style="list-style-type: none"> Although biological control of VOC/HAP emissions is not particularly new or innovative, of all the alternatives to RTOs/RCO (regenerative catalytic oxidizer), it has the best performance and seems to be closest to commercial viability. This project is addressing the important barriers to commercial implementation.
P3. Project Management		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> The team is complete and able to commercialize. It has done so in various stages outside the forest products industry. 	<ul style="list-style-type: none"> They have a good mix of team members and are meeting objectives. Permit issues have been investigated. The PIs must take responsibility for correctly estimating energy savings. 	<ul style="list-style-type: none"> PI is very knowledgeable in subject matter and presented the project well. Team seems good. Project is making good progress towards objectives.
P4. Commercialization Potential		
Numerical Score: 3, 2, 2		
<ul style="list-style-type: none"> There are commercial applications using various stages of this technology outside the forest products industry; however, there are a few used in the industry. The pilot at Stimson is the latest version of the technology and has a good chance of going forward. 	<ul style="list-style-type: none"> Prototype installed and performing satisfactory. Good team to commercialize. Market uncertain 	<ul style="list-style-type: none"> This project does seem ready for commercialization. Necessary performance criteria have been demonstrated. Further DOE funding is probably not required.
P5. Project Fit into Portfolio		
Numerical Score: 1, 2, 1		
<ul style="list-style-type: none"> This technology saves gas, but not steam. There are competitive processes in the portfolio, but having several is good, as what may fit one place will not necessarily fit another. Variations of this technology with a larger footprint have been installed at a plant-scale in the wood products industry. There was some difficulty with the large footprint and 	<ul style="list-style-type: none"> There are several projects aimed at lowering VOCs and HAPs and the industry does not need all of them. A process to compare and sort out is recommended. 	<ul style="list-style-type: none"> This project is a good fit with the ITP-FP portfolio in reducing natural gas consumption.

channeling within the bed— which was spread over a football field-sized space.		
--	--	--

Project: Fibrous Fillers to Manufacture Ultra High Ash/Performance Paper		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 4, 3		
<ul style="list-style-type: none"> This project needs a life-cycle energy and environmental analysis with a process flow sheet to clarify the proposal. The presentation helped hugely. The case drawn is very conservative, as the opportunities for the mill to make the same amount of paper and sell 40% of the pulp manufactured or add a paper machine and add 2/3 to the paper output not discussed. 	<ul style="list-style-type: none"> The estimate was the most conservative decreasing pulp mill output. If the mill production is kept constant (by perhaps closing others), or if the benefit of new products is considered, the estimate will be a multiple of that given. 	<ul style="list-style-type: none"> The PI did a very nice job of articulating the energy benefits and they could be potentially significant.
P2. Innovation and Technical Risk		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> The innovation here is very high as the technology potentially changes the industry. Each mill could be much larger. With a fixed demand for paper in the U.S., 40% of the current capacity could be displaced by expansion of the other 60%. There is a practical political issue related to shrinking the number of mills if this technology is successful; a number of jobs could be lost, although the remaining mills may be more competitive. One of the things that DOE should consider what could be done with pulp mills that no longer make paper pulp. There was mention of conversion to making fuel, both ethanol and bio-diesel, utilizing some of the same equipment 	<ul style="list-style-type: none"> Of the 24 projects that were presented, I think there were only two that could result in new products. This was one of them. This was also one where the PI is likely to encounter personal risk if the project is unsuccessful. 	<ul style="list-style-type: none"> This project scores well on innovativeness, and although on-going for a while, still seems to be making good progress.
P3. Project Management		
Numerical Score: 1, 2, 2		
<ul style="list-style-type: none"> While the team has apparently dealt well with the technical hurdles (except for completing certain tasks), the interaction with the industry has been small and apparently at the technical level. At this point in project development there should be much more industry 	<ul style="list-style-type: none"> Significant progress from inception to a prototype plant with few industrial supporters to date. Yet some milestones were missed which lowered the rating below from good to average. Also note that paper companies do not put capital into precipitated calcium carbonate (PCC) plants. They 	<ul style="list-style-type: none"> The PI seems to be addressing the critical issues but little outside GRI involvement.

<p>involvement.</p> <ul style="list-style-type: none"> This project will fail if there is not more industry involvement. 	<p>are financed, built and operated by vendors with a “take” contract. The major conventional PCC vendors are likely to have negative interest in this project.</p>	
P4. Commercialization Potential		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> Here is where the lack of industry involvement hurts the most. It does not appear that firm(s) would be interested in using this technology. Perhaps if the work at Grays Harbor Paper will be helpful, but a mechanism to get the information from the trials about the technology out to the industry is critical. 	<ul style="list-style-type: none"> A prototype plant has produced T2, which has been accepted by the mill. T6 is next. If successful, someone will emerge to finance the prototype plant into a full-scale commercial plant. The next target market is non-integrated mills that buy their pulp as this process can use boiler stack off gas with low CO₂. Current PCC plants require ~20% CO₂ from lime kilns, etc. The downside is that this will require someone with deep pockets or large borrowing capacity. This greatly lowers to number of investors and lowers the probability of commercialization. 	<ul style="list-style-type: none"> The plan is to license the technology to appropriate entities, which is always a risky commercialization strategy except for breakthrough technologies.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> This is one of several ways to save energy and steam and thus, fits the portfolio well. Perhaps the question about fitting into the portfolio should also include something about likelihood of commercial success. If that were the case, this project would be rated lower. 	<ul style="list-style-type: none"> This is one of the few projects that appears to deserve increased resources. 	<ul style="list-style-type: none"> This project does address steam savings and hence, is a good fit with the portfolio objectives.

Project: Development of Methane de-NO_x Reburning Process for Wastewood, Sludge, and Biomass Fired Stoker Boilers		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 2, 3		
<ul style="list-style-type: none"> This technology is robust in that it is used on coal and waste-to-energy (WTE) units. The coal is probably more important than the biomass. Being able to eliminate natural gas use in some circumstances is an added plus. 	<ul style="list-style-type: none"> This started out as a project with heavy environmental drivers and the team seems to have discovered that energy savings through fuel switching would be a better driver. I question the predicted market size. 	<ul style="list-style-type: none"> The claimed energy savings come from increases in boiler thermal efficiency from implementation of this technology. Natural gas savings should result from better control of boiler operation.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> This technology has been applied in enough places that the initial risks/burdens have been overcome. Still, the 	<ul style="list-style-type: none"> There appears to be a lot of trial-and-error and empirical information. However, a lot of progress has been made. 	<ul style="list-style-type: none"> This project is not particularly innovative in the sense that proven methods are being utilized to obtain better boiler combustion control.

process is a good example for innovation.	<ul style="list-style-type: none"> The Pulp and Paper Research Institute of Canada (PAPRICAN) seems to have a superior technology that was confined to member companies for the last 3 years but is now available to all for a fee. They achieved thermal increases of 7-30% on recovery boilers and solid fuel boilers in Canada with MINIMAL capital. This is a principle driven approach that is commercially PROVEN. Vic Uloth has published several articles and I am disappointed that this group is not aware of any of this. 	However, these techniques should result in more efficient boilers.
P3. Project Management		
Numerical Score: 3, 2, 2		
<ul style="list-style-type: none"> The team has all the operating components for a successful program, except a champion in the forest products industry; Boise was initially, but the interest seems to have fallen with ownership changes. 	<ul style="list-style-type: none"> The team has changed. ESA has replaced Detroit Stoker. Wohaldo replaced Bryan. The first team seemed to miss the fuel-switching driver. The second team missed a more advanced competing technology of PAPRICAN. However, they did make progress and achieved commercial installations. 	<ul style="list-style-type: none"> Technical team assembled seems good with appropriate expertise. PI is very knowledgeable in subject manner. Project has done a good job of accomplishing objectives.
P4. Commercialization Potential		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> The number of commercial installations in all industries says that this is commercial. There is a potential competitor from Canada that may surpass this technology. The Canadian technology has been developed in the forest products industry. This technology has had success in the coal-fired power industry and the WTE industry. In these two industries, it clearly has an advantage over the Canadian technology because it has been applied there and the transfer of the Canadian technology to other industries may take some time. 	<ul style="list-style-type: none"> This technology has been available and previous efforts to commercialize in pulp and paper had limited success. The difficulty of permitting issues has not been recognized. Also there is a commercially proven, superior competing technology. 	<ul style="list-style-type: none"> Since this is a service and not a technology, there should be a good plan towards commercialization. This is a good approach and industry would be wise to implement it. Continued DOE funding does not appear to be required.
P5. Project Fit into Portfolio		
Numerical Score: 1, 3, 2		
<ul style="list-style-type: none"> This project saves fuel, increases efficiency of steam generation, has environmental benefits, and can burn waste. It does not save steam, but can produce additional steam. 	<ul style="list-style-type: none"> The recent "discovery" that this technology can allow facilities to use more biomass and less fuel, is good and will be a boost to previous efforts. However, this generally requires a permit change. 	<ul style="list-style-type: none"> This project is a good fit with the ITP-FP portfolio in reducing natural gas usage and increasing steam production.

<ul style="list-style-type: none"> This technology is for retrofits in the forest products industry. It does not enable either biomass or wood gasification. 	<p>Also, this is not pure energy savings but a combination of improved thermal efficiency and fuel substitution.</p>	
---	--	--

Project: Mechatronic Design and Control of a Waste Paper Sorting System for Efficient Recycling		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 2, 1, 1		
<ul style="list-style-type: none"> This technology claims a small energy saving, but does not consider all the potential savings. It has considerable public benefit which would enable society to recycle more valuable paper. Not only can more paper be recycled, but the quality will also improve. The energy benefits will accrue to the paper mills that use the better quality fiber which can be recovered. 	<ul style="list-style-type: none"> The PI was very unclear about this, but stated that it was low. I think there are energy savings and will give it a low, but positive rating. 	<ul style="list-style-type: none"> Savings are indirect. The claimed savings come from a higher utilization of the waste paper stream through the use of this sensor technology.
P2. Innovation and Technical Risk		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> This project continues to be remarkably innovative. It has overcome many technical barriers. Some of the earlier developments in the project have moved successfully to a few full-scale recycling facilities. This means that the this technology has a good likelihood of expanding. 	<ul style="list-style-type: none"> This is a new process. The design is innovative and of value, it is an incremental process. 	<ul style="list-style-type: none"> This project is for an on-line stiffness detector and is a continuation of an earlier project for a lignin sensor. The goal is a sensor array for detecting and ultimate control of important paper parameters related to recyclability. The goals are ambitious and should be impactful. One concern is that the project is not taking maximum advantage of existing technologies and methods. The research approach is highly innovative.
P3. Project Management		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> There appears to be a complete team to carry the project through to even more complete commercialization. 	<ul style="list-style-type: none"> Good team that is on schedule. PIs must take responsibility for accurately estimating energy impact. 	<ul style="list-style-type: none"> This project appears to be well managed with a good project team and is making good progress towards objectives.
P4. Commercialization Potential		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> Several of the developments from this project have been commercialized and it appears that another sensor could be also. From a commercialization perspective, this project is one of the more successful in Panel 2. 	<ul style="list-style-type: none"> Parts of the work have already been commercialized. Looks like other parts will also. 	<ul style="list-style-type: none"> This project has a good plan and approach towards commercialization, plus the team has already been successful with a similar effort.
P5. Project Fit into Portfolio		
Numerical Score: 1, 1, 1		
<ul style="list-style-type: none"> This project saves some 	<ul style="list-style-type: none"> Nice project that may have 	<ul style="list-style-type: none"> This project is not a particularly

<p>energy, but claims zero steam savings. There is some electricity saving.</p> <ul style="list-style-type: none"> • It is not redundant so far, but the recognizing question (currently outside the scope) might be redundant with the elimination of pressure sensitive adhesives (PSAs) in another project. I would prefer to have two approaches, as the chances of success increases. • The public benefit of this project is high and if that weighed on the scale, the rating would be higher. 	<p>higher energy impact that the Pls predict. They need a more rigorous estimate.</p>	<p>good fit with reduced natural gas usage or decreased steam demand.</p>
---	---	---

Project: VOC and HAP Recovery Using Ionic Liquids		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> • This project is based on replacing thermal oxidizers; as such, large quantities of gas will be saved, but not steam. • It is potentially applicable to many wood product plants and pulp mills. 	<ul style="list-style-type: none"> • This is highly dependent on how many real-time operating systems (RTOs) will be replaced and the author was reluctant to predict. 	<ul style="list-style-type: none"> • This project is based on replacing thermal oxidizers and not steam, but the energy benefits seem good.
P2. Innovation and Technical Risk		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> • Loss potential of ionic liquids is critical. • Needs life-cycle perspective on energy and environment to understand environmental impacts, which are not adequately addressed. • Technical characteristics of ionic liquids (i.e., viscosity, etc.) are risks that may make alternate technologies more attractive. 	<ul style="list-style-type: none"> • This is a new process that is not well understood. The absorbers tests to date have not met EPA regulation, but more work is planned. 	<ul style="list-style-type: none"> • This project is innovative in investigating the use of ionic liquids for VOC and HAP recovery versus the conventional RTO or RCO (regenerative catalytic oxidizer) technology. • Considerably more research is required to adequately demonstrate the efficacy of this approach.
P3. Project Management		
Numerical Score: 1, 2, 2		
<ul style="list-style-type: none"> • With three large industrials signed on, there should be a good team. However, the industry's involvement is not apparent. • This technology is sufficiently different from other VOC reduction technologies, as well as involving a quite different liquid, that the lack of involvement of the identified industrials causes concern. 	<ul style="list-style-type: none"> • Not all aspects have been considered. • Desorption is not working well enough to be commercial. • Particulate matter may not be covered well enough. However, there are suppliers and end users involved. I am not sure how committed they are because research to date does NOT confirm that EPA rules can be met. 	<ul style="list-style-type: none"> • Research seems to be well-focused towards accomplishing the project objectives. Team is good, but involvement of industrial partners is unclear.

P4. Commercialization Potential		
Numerical Score: 2, 1, 1		
<ul style="list-style-type: none"> • This approach seems to be behind other thermal oxidizer projects and may lose on a late arrival basis. • The risks with ionic liquid costs and characteristics are critical to any company's decisions to commercialize. Because of the competition, realizing the total gas reductions from thermal oxidizers with this technology is unlikely. • I speculate that the industrials involved wanted to place bets on several technologies, as they appear on other Panel 2 projects. While this may be a reasonable business practice, greater involvement should make the probability of success greater. 	<ul style="list-style-type: none"> • Project team is unsure of market. • The compound costs and any loss are critical. The statement, "Let a commercial firm develop and market a full-scale version" is not a plan, but a hope. 	<ul style="list-style-type: none"> • Since failure to meet regulatory emission standards would result in plant shutdown, this technology would have to be highly demonstrated in order to be adopted. • So far, results are far from convincing; considerably more research is required. Because of this, commercialization potential seems low.
P5. Project Fit into Portfolio		
Numerical Score: 1, 2, 1		
<ul style="list-style-type: none"> • As stated above, this project saves gas, but not steam. • It is one of many competitive technologies for the identified target in the portfolio. • It is good to have several projects such as this, as one is more likely to find success after R&D on several rather than betting on one before researching. 	<ul style="list-style-type: none"> • There are several projects aimed at lowering VOCs and HAPs and the industry does not need all of them. A process to compare and sort out is recommended. 	<ul style="list-style-type: none"> • This project saves gas, but not steam. However, potential for significant savings are good.

Project: Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 3, 3		
<ul style="list-style-type: none"> • This project needs a life-cycle analysis for energy and environment, as well as a good explanation of how and what kind of energy saved will be achieved. • The energy savings claim is large, but needs support, which did not appear in the oral presentation. 	<ul style="list-style-type: none"> • I do not have the skills to verify the impressive energy calculations. Buddy Showalter at AF&PA could do this, if needed. • This is one of the "high end" wood products opportunities. 	<ul style="list-style-type: none"> • This project needs better oral and written explanation of how and what kinds of energy savings claimed will be achieved.
P2. Innovation and Technical Risk		
Numerical Score: 2, 2, 1		
<ul style="list-style-type: none"> • Low temperature curing is a substantial step forward. Nevertheless, the oral presentation brought up a number of technical issues 	<ul style="list-style-type: none"> • While the scientific principals are understood, the technology's application does not appear to be well-understood. 	<ul style="list-style-type: none"> • The project has a very systematic approach to address its objectives, however, the project seems low on the innovative scale.

that must be addressed before possible success. They include: moisture variation in the veneer, the high viscosity of the glue and the resultant spreading problem, personnel sensitivity to the adhesive in a production environment, etc.		
P3. Project Management		
Numerical Score: 3, 2, 3		
<ul style="list-style-type: none"> There is clearly a good group of technical personnel to carry the project forward. As long as the potential user, Weyerhaeuser, remains actively involved and interested, there will be a capability to commercialize. 	<ul style="list-style-type: none"> There needs to be some effort to understand the capital and operating economics of the new manufacturing system that required. Also, some heat to the process may be of significant technical value. 	<ul style="list-style-type: none"> The project appears to be well-managed towards accomplishing the objectives with an appropriate team. The project organization around addressing the major barriers towards commercialization is very good.
P4. Commercialization Potential		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> At this point, there are several significant technical issues to overcome. The first application should be in a Greenfield plant in order to not risk an operating plant with a retrofit. Also, the design should be such that if the technology was a commercial failure, the plant could be retrofitted for the existing technology. The dominant phenol-formaldehyde technology in North America is unique. Apparently in other markets, such as the European Union, phenol-formaldehyde is not used as an adhesive for environmental reasons. North America often adopts technologies from overseas that have been established for a variety of reasons. So, the development of further isocyanate technology is likely beneficial. There are a few isocyanate-based plants in the United States, but the technology is more expensive. 	<ul style="list-style-type: none"> Very hard to judge because the new process has not been totally defined. 	<ul style="list-style-type: none"> Retrofitting an existing mill with this technology would be risky. A new Greenfield would be a better target, which could act to impede the introduction of this technology.
P5. Project Fit into Portfolio		
Numerical Score: 2, 2, 2		
<ul style="list-style-type: none"> This project can save energy once it is functional. It can reduce steam if the veneer drying uses steam. Like many other projects pointed at eliminating natural gas for thermal oxidation, it can be a member of a family of technologies that DOE-ITP 	<ul style="list-style-type: none"> No comment. 	<ul style="list-style-type: none"> This project addresses natural gas reduction that is a goal of ITP-FP. It also fits nicely with the steam reduction strategy.

has to fit this natural gas reduction opportunity.		
--	--	--

Project: An Innovative Titania-Activated Carbon System for Removal of VOCs and HAPs from Pulp, Paper, Paperboard Mills, and Wood Products Facilities with In-Situ Regeneration Capabilities		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 3, 1, 2		
<ul style="list-style-type: none"> • This technology has applications in several industries and is able to remove other pollutants in addition to HAPs and VOCs. Technology has robust application. • A low amount of energy savings is claimed, but if broadly applied, could be more than claimed. • A life-cycle approach to calculating energy and environmental savings is needed. 	<ul style="list-style-type: none"> • The PI confirmed that the projected energy savings would be 12 Billion BTUs for pulp and paper. If true, this is too low to warrant R&D support from the pulp and paper industry. 	<ul style="list-style-type: none"> • As is typical for these types of projects, claimed energy/environmental benefits are natural gas savings compared to real-time operating systems (RTOs).
P2. Innovation and Technical Risk		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> • This project was quite innovative and seems to have overcome most of the technical issues. 	<ul style="list-style-type: none"> • The technical risk was not high but the team missed the attrition issue. I would like to rate this higher but it is just incremental. 	<ul style="list-style-type: none"> • Project does take an innovative approach to VOC/HAP destruction by investigating UV-activated TiO₂. PI, although convincing, glossed over some important technology issues and tends to oversell what has been accomplished.
P3. Project Management		
Numerical Score: 3, 2, 2		
<ul style="list-style-type: none"> • With the involvement of Ford, Bacon, and Davis, the team is complete and seems to be well-placed for applying the technology commercially. • It might be helpful if there was a pulp and paper mill involved. NCASI is a very good source of industrial support, but a mill perspective could be helpful. 	<ul style="list-style-type: none"> • The team has not been able to meet the EPA standard for methanol, which represents the largest volume. Also, this is a very empirical approach. However, the technology looks like it will work for other industries and is being commercialized there. 	<ul style="list-style-type: none"> • PI is very knowledgeable in subject matter, although he tends to oversell. • Project has done a good job of accomplishing objectives however, much remains to be done.
P4. Commercialization Potential		
Numerical Score: 3, 3, 1		
<ul style="list-style-type: none"> • As reported, the first commercial application will be in a chloralkali plant and other industries are in the process. Acceptance in forest products may follow. • An effort to recruit a forest products operation should be made. After the mill practicalities of the chloralkali plant are experienced, perhaps the recruiting will be easier. 	<ul style="list-style-type: none"> • RTP was hired to do a market study. A solid team has been assembled. The technology was found to have better application outside pulp and paper where it looks almost assured that it would be commercialized. 	<ul style="list-style-type: none"> • This project does not seem ready for commercialization. Serious performance issues and scale-up issues still exist that must be addressed. Not clear as to why PI believes this is ready for commercialization.

P5. Project Fit into Portfolio		
Numerical Score: 1, 0, 1		
<ul style="list-style-type: none"> This technology saves some gas, but does not save steam. There are other technologies that address the HAPs and VOCs issues in the forest product industries, but having several to select from is sound. 	<ul style="list-style-type: none"> This project will score low, but has high potential and one of the ones that I liked best. 	<ul style="list-style-type: none"> This project is a good fit with the ITP-FP portfolio in reducing natural gas usage.

Project: On-Line Oxidation of Volatile Organic Compounds Generated by Sawmill Wood Kilns		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 0, 0, 2		
<ul style="list-style-type: none"> This project does not appear to save energy and is focused on a non-problem in the forest products industry. 	<ul style="list-style-type: none"> No energy savings projected by PI. 	<ul style="list-style-type: none"> As is typical for these types of projects, claimed energy/environmental benefits are natural gas savings compared to real-time operating systems (RTOs).
P2. Innovation and Technical Risk		
Numerical Score: 0, 1, 1		
<ul style="list-style-type: none"> The project seems to have considerable technical and high cost barriers. It is not worth doing and, if successful, although very unlikely, has the potential to damage the industry through encouraging unneeded regulation. 	<ul style="list-style-type: none"> Always do a thorough bench evaluation before building larger prototypes. This might have saved time and money in this case. 	<ul style="list-style-type: none"> This project pursues a UV photolysis of H₂O₂ to reduce VOC emissions and although innovative results have not been encouraging. Based on the less than encouraging results, the project is now investigating fundamental gas phase reaction kinetics.
P3. Project Management		
Numerical Score: 1, 1, 0		
<ul style="list-style-type: none"> The team is incomplete; it has no industry involvement. 	<ul style="list-style-type: none"> Missed milestones, missed target, and failed technology. Regardless, PI wants to keep on trying without technical basis. 	<ul style="list-style-type: none"> .This project appears to be off-track and is currently being run as a fundamental kinetics analysis. Presentation was poor and lacked focus.
P4. Commercialization Potential		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> The project is unnecessary and will not achieve anything useful; I cannot see it being commercialized. 	<ul style="list-style-type: none"> There is nothing to commercialize. 	<ul style="list-style-type: none"> There is no realistic plan towards commercialization of this technology. Given the large number of these types of projects in the portfolio, this one clearly appears to be the weakest and shows little promise towards accomplishing the objectives.
P5. Project Fit into Portfolio		
Numerical Score: 0, 0, 0		
<ul style="list-style-type: none"> This project has no redeeming features and does not belong in the portfolio. 	<ul style="list-style-type: none"> There are several projects aimed at lowering VOCs and HAPs and I do not think the industry needs all of them. A process to compare and sort out is recommended. 	<ul style="list-style-type: none"> This project is a good fit with the ITP-FP portfolio in reducing natural gas usage. However, given the low probability of success, it is unlikely any benefits will be achieved.

Project: Rapid, Low Temperature Electron, X-Ray, and Gamma-Beam Curable Resins		
Reviewer #4	Reviewer #5	Reviewer #6
P1. Energy Savings and Other Benefits		
Numerical Score: 4, 3, 2		
<ul style="list-style-type: none"> This project can save large quantities of energy and steam (if presses or driers are steam driven). It also seems to create some forms that the forest products industry cannot currently make. 	<ul style="list-style-type: none"> The industry potential was estimated at 65 trillion BTU, which seemed solid. However, it is unclear which and how much of each market may switch, so total score was discounted one point. 	<ul style="list-style-type: none"> Claimed savings were for lower curing temperatures and for reduced drying.
P2. Innovation and Technical Risk		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> This project creatively took technology from other places and applied them in the wood products industry. Most barriers seem to have been overcome. 	<ul style="list-style-type: none"> This could be transformational to the wood products industry with a low energy process and several new products. Looks better than the isocyanate project (Virginia Tech). 	<ul style="list-style-type: none"> The electron-beam curable resin is an innovative approach and some good data has been generated to show the efficacy of this approach.
P3. Project Management		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> There is a complete team involved and they have developed a plan to expose their concepts to potential users. There are two good-sized industry players participating. 	<ul style="list-style-type: none"> Solid team which has met all milestones. There is a wide variety of applications and it is not possible to study all of them. 	<ul style="list-style-type: none"> PI was extremely knowledgeable with a very good systematic research approach. Team was very good with clear involvement of industry. The roles of participants and ITP-FP seemed jumbled at times.
P4. Commercialization Potential		
Numerical Score: 2, 1, 2		
<ul style="list-style-type: none"> The first commercial user has not stepped forward, but should this summer. The attractions for commercialization are high; once one or two build plants, a large group is likely to follow.. 	<ul style="list-style-type: none"> Need clearly identified and technology appears applicable, but it will represent a "step change." The path to commercialization was unclear. There does not appear to be anyone stepping forward. 	<ul style="list-style-type: none"> Commercialization potential seems good. Although, it is not clear as to what the project specifically developed.
P5. Project Fit into Portfolio		
Numerical Score: 3, 3, 2		
<ul style="list-style-type: none"> This project clearly belongs in the portfolio. It meets the energy and steam foci. 	<ul style="list-style-type: none"> This appears to be a candidate for continuation to identify commercialization path forward. 	<ul style="list-style-type: none"> This project is a good fit with the ITP-FP portfolio in reducing natural gas usage and has a very near-term potential.